

REPORT
OF THE
WAR DEPARTMENT
—
1900

VOL. 1

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PART 12.
REPORT
OF THE
MILITARY GOVERNOR OF CUBA
ON CIVIL AFFAIRS
IN TWO VOLUMES
VOL. 2—IN FOUR PARTS
PART 3

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ANNUAL REPORTS

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OF THE

WAR DEPARTMENT

FOR THE

FISCAL YEAR ENDED JUNE 30, 1900.

PART 12.

REPORT OF THE
MILITARY GOVERNOR OF CUBA ON CIVIL AFFAIRS.

IN TWO VOLUMES.

VOL. II—IN FOUR PARTS.

Part 3.

WASHINGTON:
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1901.



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Report of Maj. William M. Black, Corps of Engineers, U. S. A., chief engineer of
the Division of Cuba.



MAJ. WILLIAM M. BLACK, CHIEF ENGINEER, DIVISION OF CUBA.

REPORT
OF
MAJ. W. M. BLACK, U. S. A., CHIEF ENGINEER.

HEADQUARTERS DIVISION OF CUBA,
Habana, July 31, 1900.

SIR: I have the honor to transmit herewith report of the engineer department for the fiscal year ending June 30, 1900.

Very respectfully,

H. L. SCOTT,
*Assistant Adjutant-General, in Charge of
Civil Affairs, City of Habana.*

ADJUTANT-GENERAL, DIVISION OF CUBA.

SIR: I have the honor to submit the following report on the operations of the engineer department, Division of Cuba:

The engineer operations in the island, in direct charge of the military authorities, have been carried on under the orders of the department commanders without any particular organization excepting in the Department of Habana.

With the very poor means of communication in many parts of the island, the absence of any detailed local information at division headquarters, and an enormous amount of sanitary and relief work, which had to be done promptly, throughout the island, it was necessary to give great discretionary powers to department and district commanders.

The various works were placed under the charge of officers stationed near their respective locations, and the objects and amounts expended fixed by the department commanders, subject to orders and allotments from the division headquarters. Much good work has been done in sanitation in the various cities and towns in the sanitation and repair of public buildings, in providing water supply, and in building roads and wharves—all as shown in detail in the reports of the various department commanders.

In the Departments of Matanzas and Habana the department engineer officers have been officers of the Corps of Engineers. In the other departments officers of other branches of the service were detailed for these positions in the absence of officers of the Corps of Engineers.

At the end of December, 1899, a chief engineer was appointed for the division, and it was determined to make a gradual organization of

the engineering work in Cuba, turning over to the department of public works all works save those of sanitation as rapidly as that department could be prepared to receive them.

In January the former department of agriculture, industries, commerce and public works was divided and a separate department of public works was formed with a secretary at its head. The department was organized and the personnel appointed and installed. On January 19, by Order No. 29, cooperation was directed between the military and civil officials charged with public works. The following extracts from this order refer directly to the engineer work:

VI. The relations between the civil and various military officials should be one of harmony and mutual support.

VIII. The various department commanders are charged with the maintenance of public order, in the general sense of the term, sanitation, the conduct of all public works of a sanitary character, and the completion of public works now being constructed under their charge. They are also charged with the organization, command, and administration of the rural guard.

XIV. The chief of public works and military engineers in each department will be associated (two officials—the military engineer officer of the department or district, as the case may be, and the chief of public works) for the purpose of instructing the chief of public works in the methods employed in the Engineer Department of the Army of the United States in estimating, contracting, construction, and general conduct of public works.

XV. On and after the 1st day of April, 1900, all public works will be placed under the direct supervision of the provincial chief of public works, the military engineer officer continuing in the office as an inspector, reporting upon the character of the work, method of construction, necessity of expenditure called for, etc. In short, he will directly represent the military governor of the island and act, through the department commander, as his personal inspector in all matters pertaining to the expenditure of the funds of the island for public works. All details of the conduct of public works will be vested in the chief of public works, under the general supervision of the secretary of public works. This plan will result in the chief of public works becoming thoroughly familiar with the records of the military officers who have, up to date, had almost entire charge of public works in the island of Cuba, and when the time comes for the complete separation of the two officials, the chiefs of public works will be in possession of all the data necessary to successfully continue the administration of their office.

The Spanish regulations and laws for the conduct of the public work were found to be cumbersome and obstructive and unfit for a working code, and it became necessary to frame a set of regulations under which the public works could be conducted. By direction of the military governor a draft of regulations was prepared by the chief engineer of the division and the secretary of public works, based on the United States Army Regulations and the Regulations for the Government of the Corps of Engineers, United States Army. The translation of the regulations into Spanish proved to be very laborious on account of the lack of exact equivalents for the English technical terms, so that the decree establishing the regulations could not be published until May 28, when it was published as Order No. 220.

On April 14, by Order No. 155, an organization of the engineering works carried on by the department commanders was provided for. From various causes this has not yet been wholly carried into effect. On June 28 another step was taken toward complete organization by the publication of Order No. 249, for the regulation of public works in charge of the military authorities. This provides for a system of reports to the headquarters of the division and for an administrative audit of accounts in addition to the regular work of the auditor of the

island, and also formulates the rules for the conduct of the works, for the expenditure of funds and for the care of property.

On June 9 orders were issued by the military governor for the transfer, on July 1, of public works outside of garrisoned towns to the department of public works, in the provinces of Pinar del Rio, Matanzas and Puerto Principe. On July 14 similar orders were issued regarding the public works in the provinces of Habana and Santa Clara for a transfer on August 1. These transfers are now being made.

The chief engineer of the division has supervision over all engineer work in the city of Habana, and direct charge of the works of the port at that place, of the military survey of the former department of Habana, and of the sanitation and repair of various public buildings. He has for assistants Capt. A. H. Weber and Capt. T. L. Huston, late of the Second Volunteer Engineers, and Mr. H. F. Happer as clerk. For other clerical and drafting work he receives assistance from the force of the engineer department, city of Habana.

The reports on the works in the direct charge of the division engineer are found with the report on the engineer department, city of Habana, within which these works are situated.

In addition, inspections have been made and reports submitted on many works throughout the island. The following are some of the principal subjects not reported elsewhere:

Inspection and report on the Tricornia Railroad as to cost of construction; organization and inspection of survey of Cardenas Harbor, department of public works; organization of the permanent force, department of public works; dredging in Santiago Harbor; project for road from Columbia Barracks to Habana; reports of San Jose wharf concession and on Taylor concession, Habana; report on use of wharf line, Habana, and means of acquiring additional wharf space; the reports on various projects for construction of roads throughout island; report on military zones around the fortifications, Habana; inspection and report on public works, Cienfuegos, Manzanillo, Santiago and Guantanamo; inspection and report on dredging at Isabela de Sagua.

In accordance with orders from superior authority, instructions were issued to the department engineer officers relating to data for a military map of the island. The question of water supply for Santiago was examined into and reported upon after a personal inspection, and a plan for a sewer system for Santiago was prepared in the office of the engineer officer, department of Santiago and Puerto Principe, under the direction of the division engineer, and report and project submitted. Quite a large amount of time was also consumed in assisting in the preparation of a charter for the city of Habana.

ENGINEER DEPARTMENT, CITY OF HABANA.

[P. D. Cunningham, chief engineer.]

The engineer work of the city was, until April 30, carried on as a part of the engineer department, department of Habana, since which time the organization has been kept intact as the engineer department of the city, except the department of works of the port, the sanitation and repair of certain state buildings and the survey of the terri-

tory which was included in the department of Habana, which are directly under the chief engineer of the division. These works being wholly or in part within the city of Habana are reported upon as a part of the engineer department of the city. As a matter of convenience the operations of the pay and property departments have included those works.

The organization, as reported upon, consists of: 1, general office force, including offices of chief clerk and record division; 2, pay department; 3, property department; 4, department of streets; 5, department of street cleaning and parks; 6, department of water and sewers; 7, department of works of the port; 8, sanitation and repair of public municipal buildings; 9, sanitation and repair of state buildings; 10, office of municipal architect; 11, survey department of Habana.

GENERAL OFFICE FORCE.

[Mr. C. C. Gardner, chief clerk, in charge.]

This force has charge of the general affairs and work of the office and of keeping the records, and consists at present of 6 clerks in the office of the chief clerk and 4 in the record division.

The record division is directly under Mr. C. N. Ryan, chief record clerk. The card-index system is used in this office, and a record is kept of all communications and maps passing through the department.

All the records have been carefully revised and the work of the office has been organized. The following is a statement of the work done:

| | |
|---------------------------------------------------------------------|--------|
| Number of cases recorded up to July 1, 1899..... | 4,909 |
| Number of cases recorded from July 1, 1899, to June 30, 1900 | 6,314 |
| Total number of cases since the organization of the department..... | 11,223 |
| Letters received since July 1, 1899 | 12,061 |
| Letters sent since July 1, 1899 | 2,498 |
| Indorsements of chief engineer since July 1, 1899..... | 6,391 |
| Indorsements received back since July 1, 1899..... | 4,160 |
| Total | 25,110 |

PAY DEPARTMENT.

[Capt. W. F. Smith, paymaster (July 1, 1899, to February 13, 1900); Mr. William C. Strong, paymaster (February 13, 1900, to June 30, 1900).]

At the beginning of the fiscal year the pay department, which had just been organized, and of which Capt. W. F. Smith, a bonded official, was in charge, embraced the voucher and pay-roll divisions of the engineer department. Then 9 clerks were employed in the voucher division and 11 in the pay-roll division. This organization remained substantially the same, excepting some changes in personnel, the force consisting at present of 20 clerks.

Mr. William C. Strong, who had filled the position of voucher clerk since February, 1899, was promoted to the position of paymaster February 13, 1900, vice Capt. W. F. Smith, resigned; and on the same date Mr. N. B. Stewart, chief pay-roll clerk, who had organized and was in charge of the pay-roll division, was promoted to the position of voucher clerk and placed in charge of the voucher division. Mr. H.

H. McGinty succeeded Mr. Stewart as chief pay-roll clerk. These men still fill the positions to which they were then promoted.

The operations of the pay department have consisted in receiving and disbursing funds pertaining to the engineer department; of keeping its financial accounts and records; attending to correspondence pertaining to payments; the preparation of money papers and financial statements, vouchers, and pay rolls—in fact, the regular work of a paymaster's office.

The organization has relieved the engineer officer in charge from duties of a disbursing officer; relieved his assistant engineers of the work of assisting in the payment of pay rolls, and has enabled them to devote much more time to engineering work, while full supervision is maintained over all payments.

Payments to laborers, which until June 1, 1900, were made, as far as practicable, three times per month, have since been paid upon rolls every fifteen days, the condition of the laborers having sufficiently improved to permit this without any hardship resulting to them. The number of laborers on the rolls at present is 2,750; and monthly employees, in which are included all above the grade of laborer or mechanic, number 341, a total departmental force of 3,091 men.

Payments to laborers are made by the paymaster in person, assisted by as many of his clerks as may be necessary for handling the duplicate rolls, calling out names, etc., and in the presence of the superintendent of the work done by the laborers. These last are formed in "cuadrillas" or gangs of 15 to 20 men, and each foreman is charged with seeing that they present themselves in proper order, and that each man duly checks the amount paid him before leaving the pay room. The general foremen and inspectors are required to be present until all the laborers in their respective districts are paid. The places and hours of payment are so arranged as to interfere as little as possible with the regular working hours of the men.

All men who fail to appear at the appointed time and place are paid upon "back pay days," which occur semimonthly.

It is believed that the practice of counting the money in the presence of the laborers, foremen, and "capataces" concerned, without the use of pay envelopes, and balancing in their presence, has done much toward bringing about a feeling of greater confidence among the laboring classes.

The accounts of the engineer department covering transactions, including transfers, then amounting to \$3,609,295.94, were inspected January 13, 1900, by Col. G. H. Burton, inspector-general, who remarked upon his inspection report: "The books, records, and accounts of this office are intelligently and systematically kept. I have scarcely ever had accounts presented to me in better form than Colonel Black's.

An average of 410 vouchers per month have been prepared and paid during the fiscal year—an increase of 221 per month over the first half of the calendar year of 1899. This increase was due to adoption of separate time books and rolls for each work; to greater competition among merchants on account of resumption in Habana of old and the establishment of new American and foreign commercial branches; to enlarged experience with conditions and improved modes of purchase which were adapted to bringing larger competition without material

increase of clerical force in the pay and property departments. This was made possible by the marked decrease during the year of bills rendered in Spanish gold and Spanish silver. Such bills consumed much time in checking and reducing to equivalents in United States currency.

Since February, 1900, the paymaster of this department has been receiving and disbursing division of Cuba funds under the direction of the chief engineer of the division of Cuba. These are indicated on the accompanying financial statement which pertains to the transactions of the pay department during the fiscal year ending June 30, 1900. All services rendered by the pay and property departments in connection with the works under the chief engineer of the division were paid for from funds allotted for the engineer department, city of Habana.

Under proper authority work has been done by the engineer department for private firms, chiefly with the dredging plant, and also for the ayuntamiento de la Habana. This work was paid for by those for whom it was done, and the amounts are also shown upon the financial statement.

Statement of expenditures, engineer department, Department of Habana, from July 1 to December 31, 1899.

| Appropriation head. | Source of funds. | Total. |
|-----------------------------------------------------|-----------------------------|-----------------|
| Barracks and quarters | Customs funds..... | \$76, 750. 07 |
| Sanitation ¹ | do | 1, 200, 815. 69 |
| | Miscellaneous sources | 1, 650. 15 |
| | | 1, 202, 465. 84 |
| Rural guard and administration ² | Customs funds..... | 35, 137. 90 |
| Public works, ports, and harbors ³ | do | 64, 525. 68 |
| | Miscellaneous sources | 11, 511. 63 |
| | | 76, 037. 31 |
| Charities and hospitals | Customs funds | 54, 639. 40 |
| Civil government | do | 1, 080. 12 |
| Municipalities ⁴ | do | 31, 891. 73 |
| Grand total | | 1, 478, 002. 37 |

Included in expenditures under these respective heads in report to April 30, 1900; was not expended on works but was turned in to the treasury of Cuba:

¹\$32,814.01 sanitation.

²\$762.01 rural guard and administration.

³\$0.06 public works, ports, and harbors.

⁴\$97.76 municipalities.

Included in expenditures under this head in report to April 30, 1900; was not expended on works but was returned to the Habana Electric Company:

³\$50.50 public works, ports, and harbors.

Statement of expenditures, engineer department, city of Habana, January 1, 1900, to June 30, 1900.

| Appropriation head. | Subhead. | Source of funds. | Total. |
|-----------------------------------------|------------------------|-----------------------------|--------------|
| State and government ¹ | Public buildings | Customs funds..... | \$4, 929. 74 |
| Public works | Public works | do | 28, 932. 09 |
| | | Miscellaneous sources | 13, 098. 47 |
| | | | 42, 030. 56 |

¹\$37,539.05 included in expenditures under this head in report to April 30, 1900; was not expended on works but was turned into the treasury of Cuba.

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Statement of expenditures, engineer department, city of Habana, January 1, 1900, to June 30, 1900—Continued.

| Appropriation head. | Subhead. | Source of funds. | Total. |
|---------------------------|---------------------------------|----------------------------|-----------------|
| Municipalities..... | Police | Ayuntamiento | \$79. 22 |
| Do. ¹ | Sanitation | Customs funds..... | 882, 519. 34 |
| | | Miscellaneous sources..... | 4, 129. 71 |
| | | Ayuntamiento | 1, 448. 25 |
| | | | 888, 097. 30 |
| Do..... | Hospitals and charities | Customs funds..... | 15, 945. 55 |
| | | Ayuntamiento | 2, 757. 36 |
| | | | 18, 702. 91 |
| Do. ² | Miscellaneous | Customs funds..... | 58, 897. 15 |
| | | Miscellaneous sources..... | 21. 25 |
| | | Ayuntamiento | 7, 147. 62 |
| | | | 66, 066. 02 |
| Military department | Barracks and quarters | Customs funds..... | 14, 295. 13 |
| Do..... | Administration and rural guard. |do | 4, 989. 94 |
| Total | | | 1, 039, 190. 82 |

¹\$243.98 included in expenditures under this head, from miscellaneous sources, in report to April 30, 1900; was not expended on works but was returned to North American Trust Company and C. G. Mendoza.

²\$31,155.48 included in expenditures under this head in report to April 30, 1900; was not expended on works but was turned into the treasury of Cuba.

³\$140 included in expenditures under this head in report to April 30, 1900; was not expended on works but was transferred to J. T. French, jr., major and quartermaster, U. S. V.

Statement of expenditures, engineer department, Division of Cuba, January 1, 1900, to June 30, 1900.

| Appropriation head. | Subhead. | Source of funds. | Total. |
|----------------------------|-------------------------------|----------------------------|---------------|
| State and government | Hospitals and charities | Customs funds..... | \$32, 277. 66 |
| | Jails |do | 4, 636. 50 |
| | Public buildings |do | 10, 118. 82 |
| Public works | Public works | Customs funds..... | 18, 056. 21 |
| | | Miscellaneous sources..... | 3, 393. 15 |
| Total | | | 68, 482. 34 |

Statement July 1, 1899, to June 30, 1900, showing expenditures under general objects of work.

[In the detailed financial statements accompanying the reports, the liabilities outstanding June 30 are included.]

| Department. | Plant. | Operation. | Total. |
|----------------------------------------------------------------------------------------------------|---------------|----------------|----------------|
| Department of street cleaning and parks: | | | |
| Street cleaning | \$13, 618. 54 | \$326, 230. 52 | \$339, 849. 06 |
| Collection of refuse | 12, 915. 00 | 1116, 510. 11 | 129, 425. 11 |
| Disposal of refuse | 68, 421. 91 | 94, 427. 27 | 162, 849. 18 |
| Parks, preservation and care of | 1, 966. 00 | 61, 668. 94 | 63, 634. 94 |
| Stables Nos. 2 and 3 (cost of and care of stock and property) | 41, 853. 35 | 92, 195. 15 | 134, 048. 50 |
| Guanabacoa | | 30, 044. 87 | 30, 044. 87 |
| Department of streets: | | | |
| Repairs to streets | 5, 274. 52 | 565, 105. 28 | 570, 379. 80 |
| Construction bunks, Fort Atares (special) ² | | | 367. 60 |
| For asphalt block paving—Custom-house, governor-general's palace, and supreme court building | | | 33, 478. 31 |
| North American Trust Company and C. G. Mendoza | | | 1, 377. 02 |
| Vento stone crushing plant and quarry..... | | | 33, 943. 12 |

*Care of animals and repairs to rolling plant and harness are charged under stables and shops.

¹Includes materials on hand.

²Works for which funds were provided by the ayuntamiento of Habana,

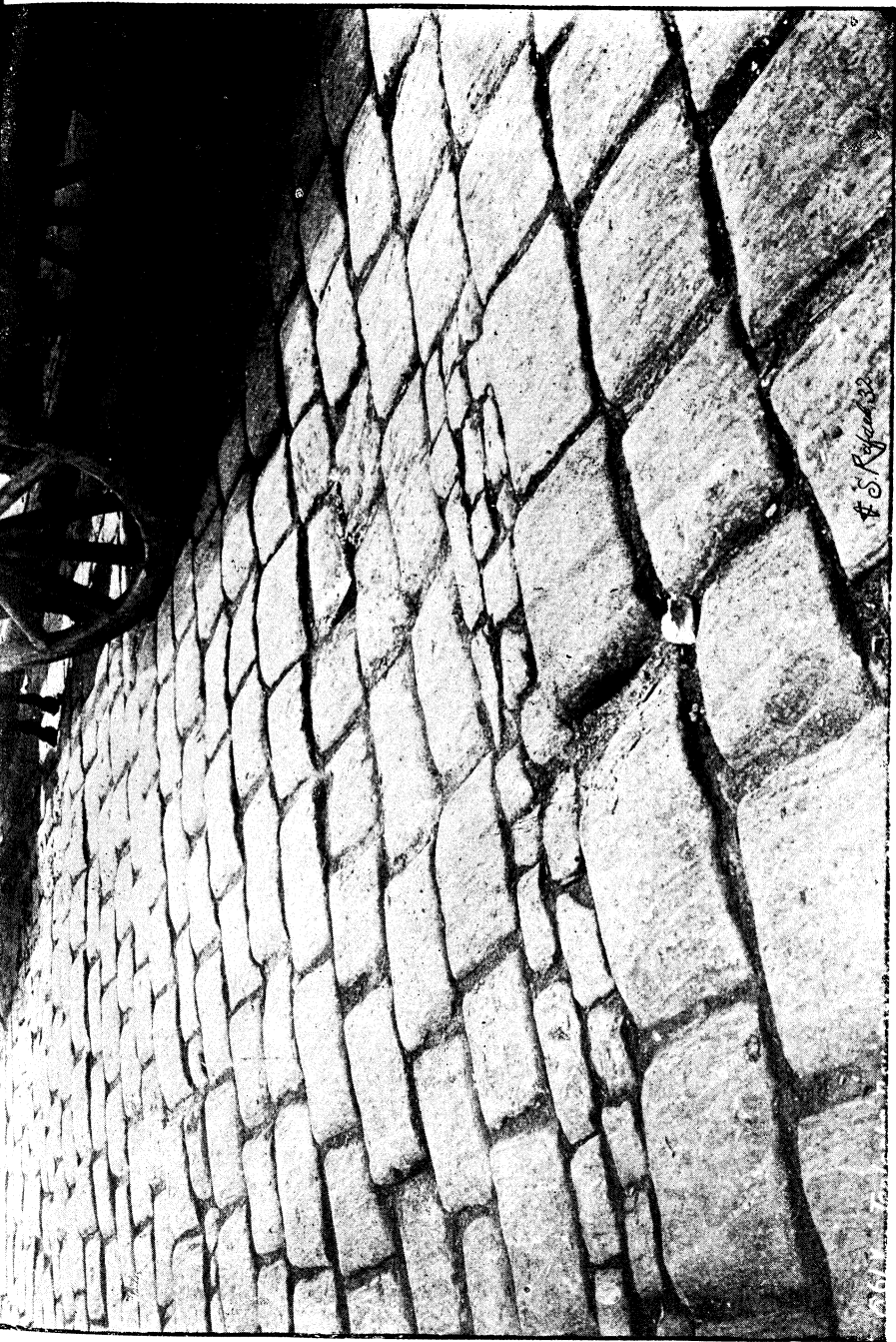
Statement July 1, 1899, to June 30, 1900, showing expenditures under general objects of work—Continued.

| Department. | Plant. | Operation. | Total. |
|------------------------------------------------------------------------------------------------------|------------|--------------|-------------|
| Department of streets—Continued. | | | |
| Stable No. 1, Fosos (including shops) | | | \$74,827.97 |
| Survey for street grades | | | 24,737.18 |
| Sewer department | \$2,880.00 | \$108,557.19 | 111,437.19 |
| Sanitary operations (removal of night soil, etc.) | 700.00 | 34,808.87 | 35,508.87 |
| Electrozone plant ³ | 64,323.16 | 10,946.00 | 75,269.16 |
| Water department | 14,457.52 | 1162,912.88 | 177,370.40 |
| Improvement, Albear canal | | | 1,323.00 |
| Installing water pipe, Tamarindo station ² | | | 104.11 |
| Improvement, Almendares River | | | 15,787.40 |
| Installing water pipe, Tacon market ² | | | 372.67 |
| Installing 4-inch main, Thirteenth street, Vedado ² | | | 603.87 |
| Improvement water supply, Quemados, Camp Columbia and Principe | | | 1,240.05 |
| Water supply: | | | |
| Regla, Luyano | | | 18,493.57 |
| Casa Blanca, Morro, and Cabana | | | 42,240.00 |
| Construction of fence, Vento and Palatino | | | 88.17 |
| Water main to Aldecoa, and other hospitals | | | 9,799.22 |
| Renovation and sanitation of buildings | | | 1,962.80 |
| Employees and incidental expenses, administration, engineer department | | | 53,381.10 |
| Office furniture and supplies, engineer department | | | 8,063.98 |
| Monthly pay and expense roll, municipal architect | | | 20,446.35 |
| Repairs at Tacon market | | | 2,438.00 |
| Repairs to— | | | |
| Municipal vivac | | | 13,618.77 |
| Estevez street police station | | | 10.00 |
| Hospital Militar, for use as carcel | | | 25,131.61 |
| Estevez street school | | | 595.43 |
| Governor-general's summer residence | | | 152.54 |
| Cuartel de Bomberos | | | 826.29 |
| Santa Venia Quinta | | | 2,790.21 |
| Jesus del Monte school | | | 1,164.22 |
| School No. 75, Seventh street, Vedado | | | 57.15 |
| Intendencia Militar | | | 382.41 |
| General repair and superintendence, all buildings | | | 22,500.51 |
| Repairs to department headquarters | | | 1,364.59 |
| Reina battery, preparing for inmates of San Jose Asylum ² | | | 154.43 |
| Vivac (closets at) ² | | | 389.96 |
| Repairs to— | | | |
| Colon market ² | | | 1,510.74 |
| Beef slaughterhouse and removal of swine slaughterhouse to same ² | | | 2,116.58 |
| Special fund for emergency repairs to city properties ² | | | 393.64 |
| Cuartel de Bomberos (construction of stalls) ² | | | 2,173.45 |
| Urgent work at Tacon market ² | | | 408.82 |
| Repairs to police station at Precinct No. 4 ² | | | 79.22 |
| Renovation and installation of laundry at Aldecoa Hospital ² | | | 26,527.67 |
| Repairs to— | | | |
| Compostela street orphan asylum | | | 26,936.83 |
| Widows' home | | | 6,686.67 |
| Reconstruction of house of succor, Casa Blanca ² | | | 523.28 |
| Repairs to Hospital Higiene | | | 1,438.00 |
| Building stable at house of succor, Amistad ⁷⁸ | | | 436.08 |
| Paving with cement tile, smallpox ward at Las Animas Hospital ² | | | 360.00 |
| Repairs to— | | | |
| Second house of succor | | | 55.75 |
| Infirmary of Presidio | | | 1,919.76 |
| Renewing gas pipe and fixtures at Presidio and Presidio Hospital | | | 770.00 |
| Construction of military stable | | | 10,246.01 |
| Installation of electric lights and water-closets at San Jose Asylum (Reina battery) | | | 27.55 |
| Purchase and installation of two boilers for Cerro pumping station and erecting shed over same | | | 4,862.29 |
| Renovation and repairs to custom-house | | | 2,213.57 |
| Renovation and cleaning old post-office | | | 20,552.39 |
| Plants, governor-general's palace | | | 750.00 |
| Repairs to— | | | |
| Cuartel de la Fuerza | | | 1,590.29 |
| Reina and Santa Clara batteries | | | 449.68 |
| Dragones barracks | | | 237.51 |
| La Punta barracks | | | 735.00 |
| Belascoain barracks | | | 686.78 |
| Maestranza de artilleria | | | 2,070.91 |
| Castillo del Principe | | | 550.00 |
| Batteries Nos. 3, 4, and 5 | | | 6,420.00 |
| Renovation of part of governor-general's palace occupied by ayuntamiento | | | 28,934.70 |
| Presidio of Cubana | | | 2,393.34 |
| Repairs to cuartel de la Fuerza for storing archives of Cuba | | | 4,223.11 |
| Installing electric-lighting plant at La Fuerza | | | 2,967.24 |

¹ Includes material on hand.

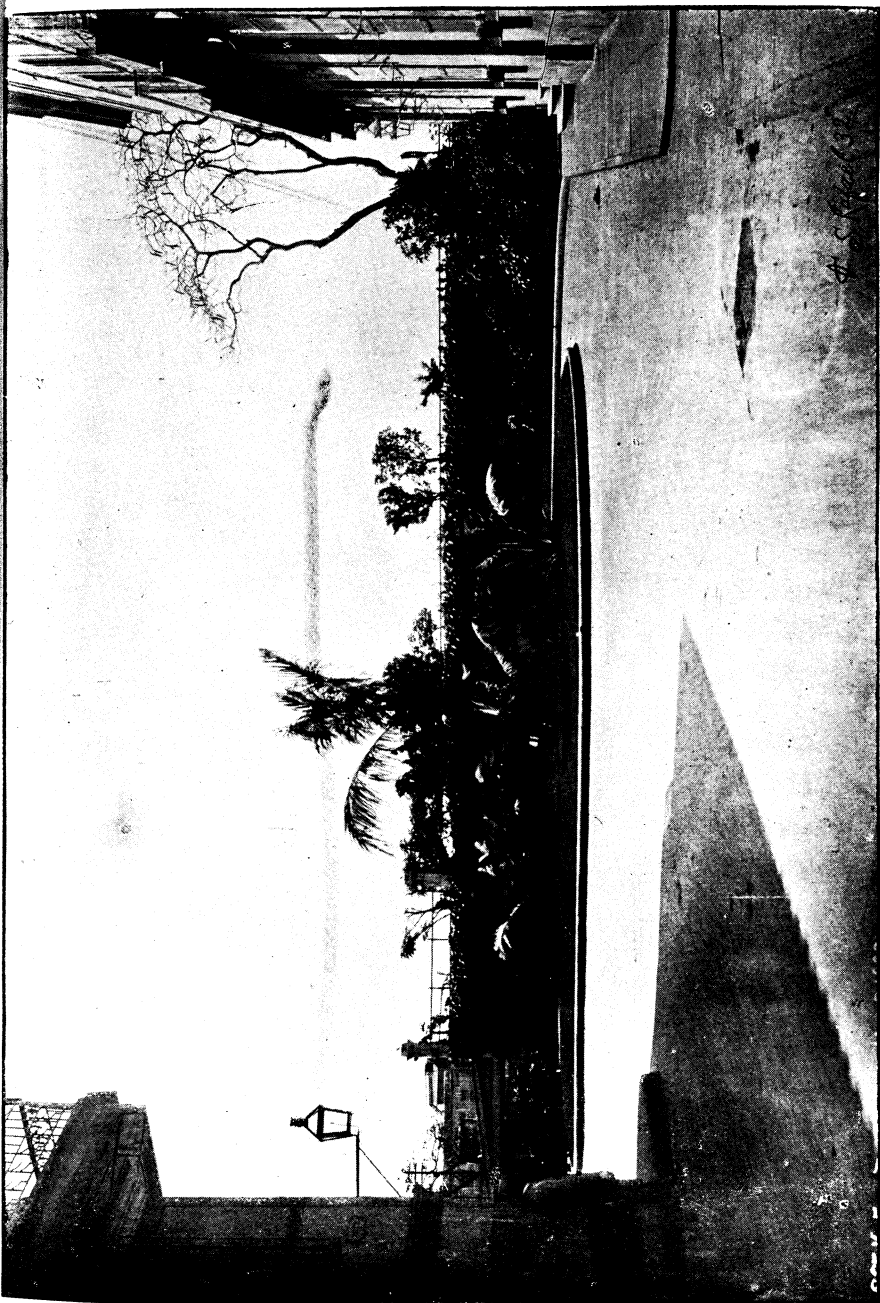
² Works for which funds were provided by the ayuntamiento of Habana.

³ In addition to \$64,323.16, as shown as expended under plant—electrozone plant—the sum of \$7,379.10 has been expended upon this object and charged to sewer department, department of streets, repairs to streets and department of street cleaning and parks, street cleaning.

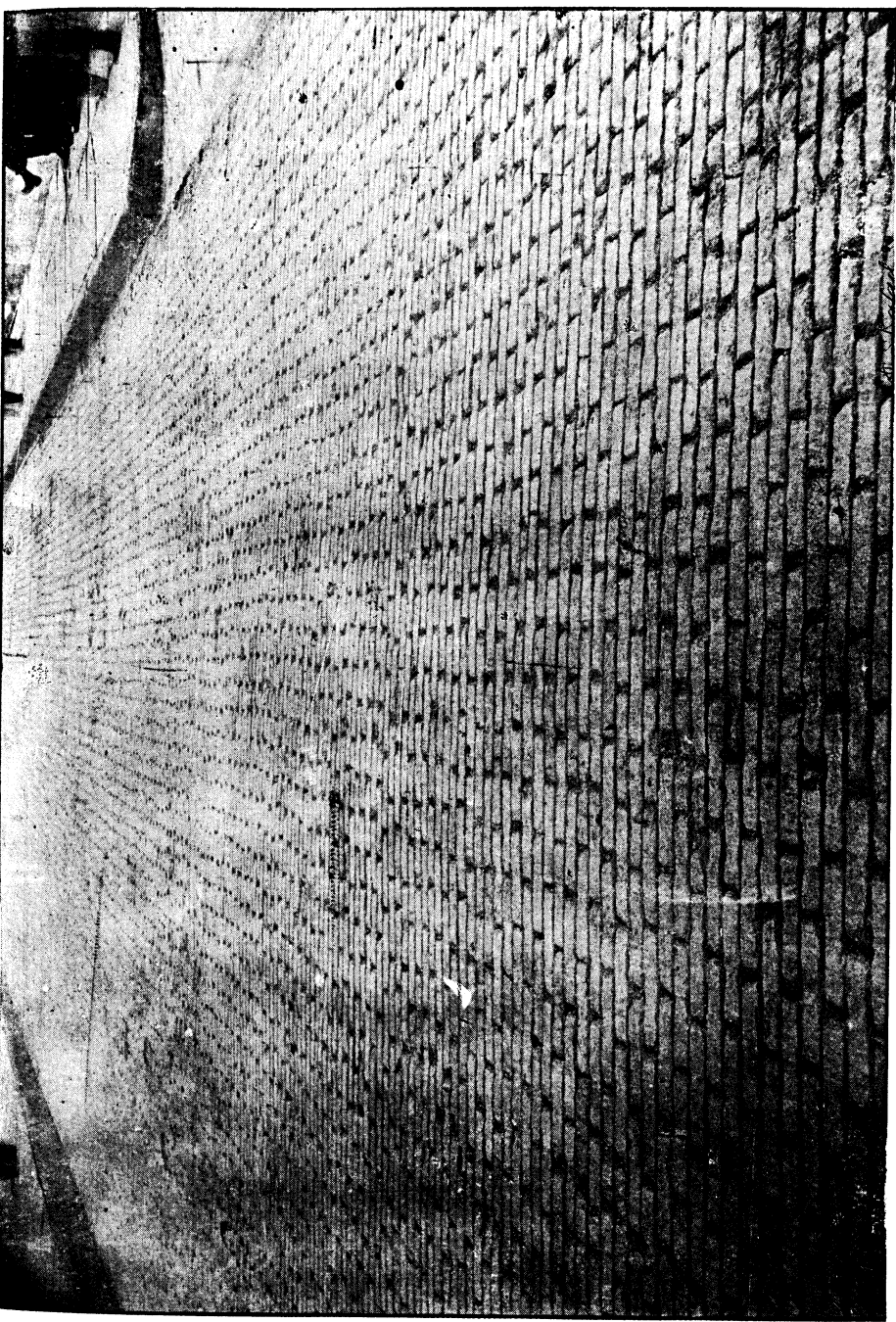


S. R. 1000 32

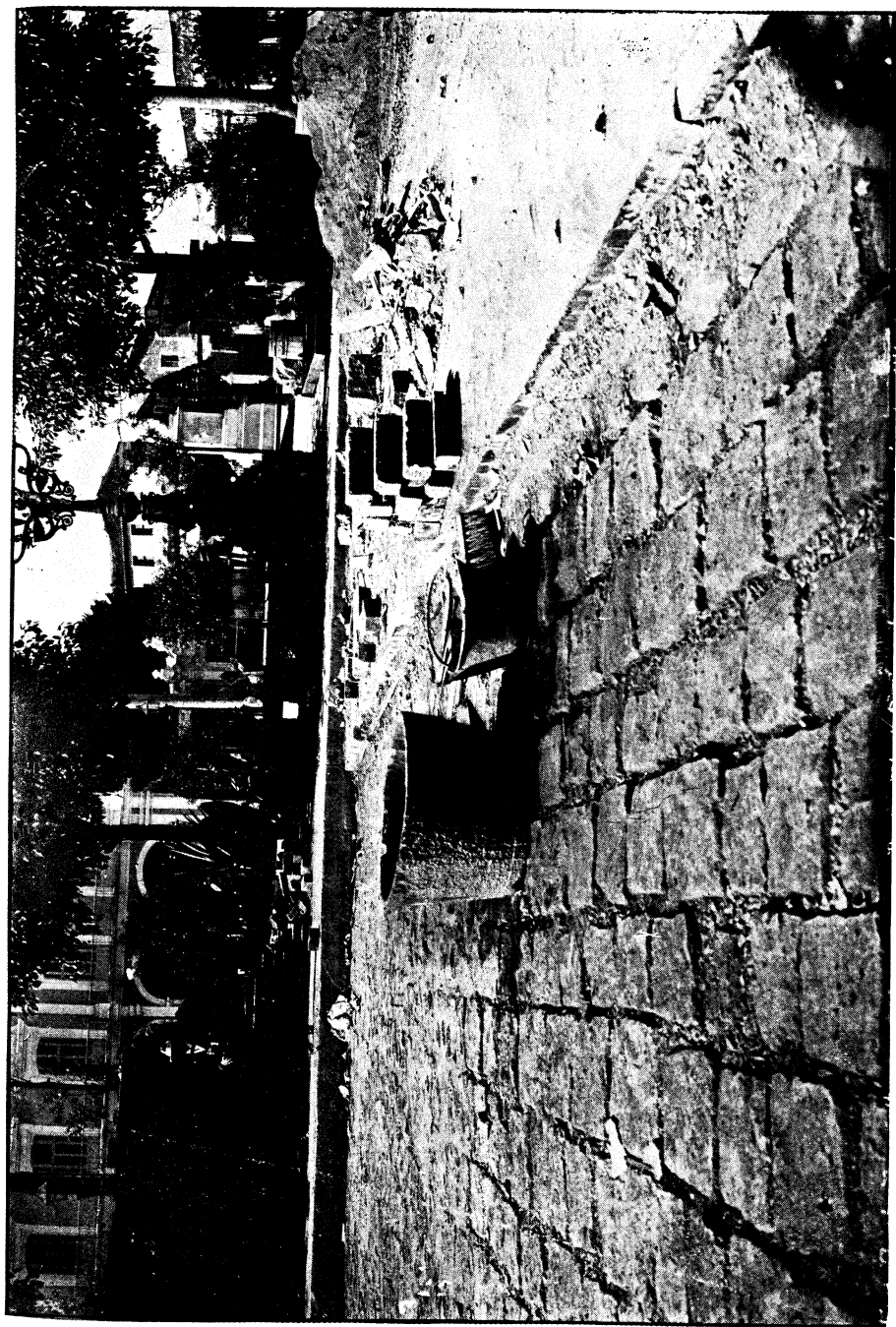
BOSTON BLOCK OFICIOS.



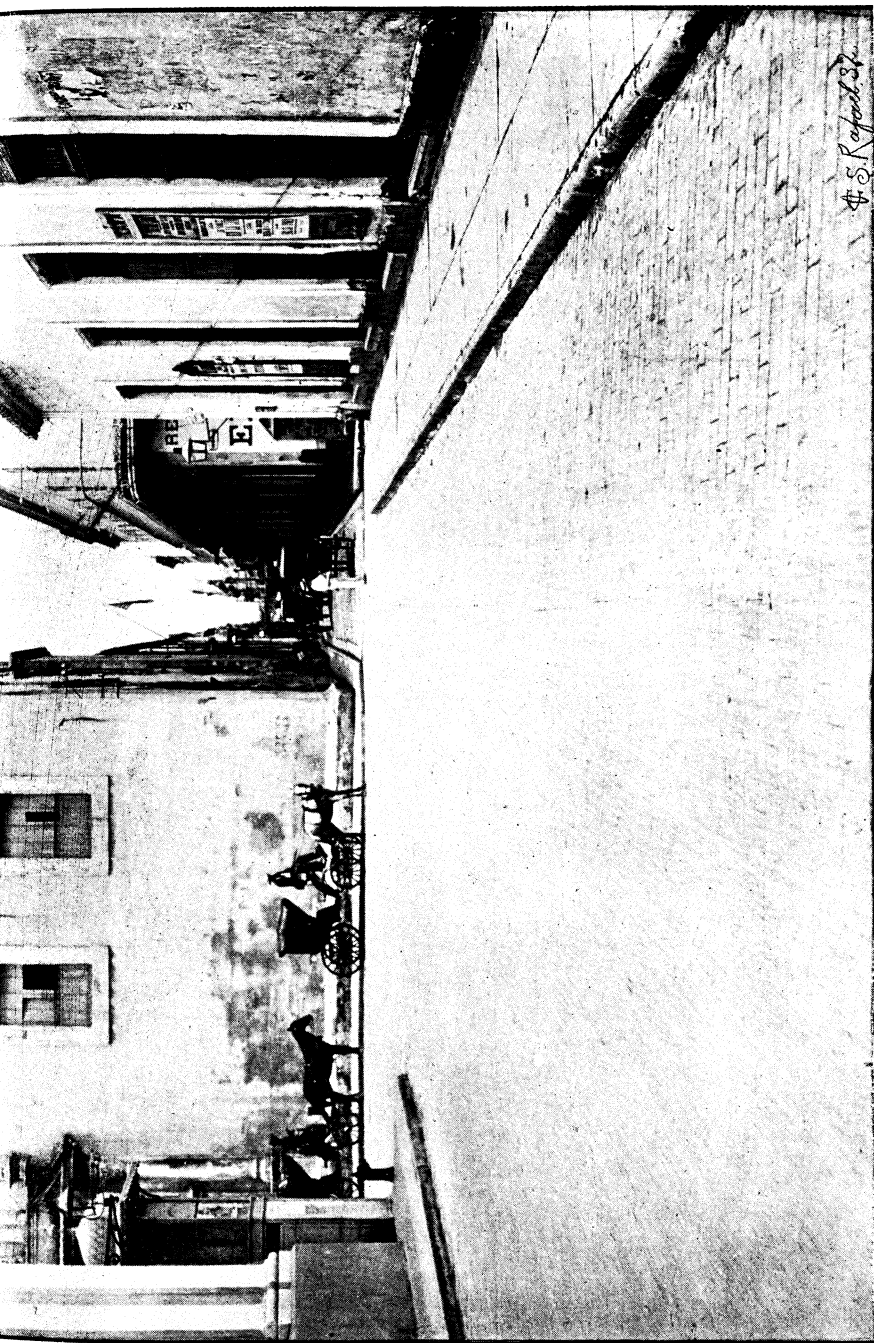
TEST PAVEMENT. SHEET ASPHALT, SHOWING WORST PLACE. (PHOTOGRAPHED APRIL 30, 1900.)



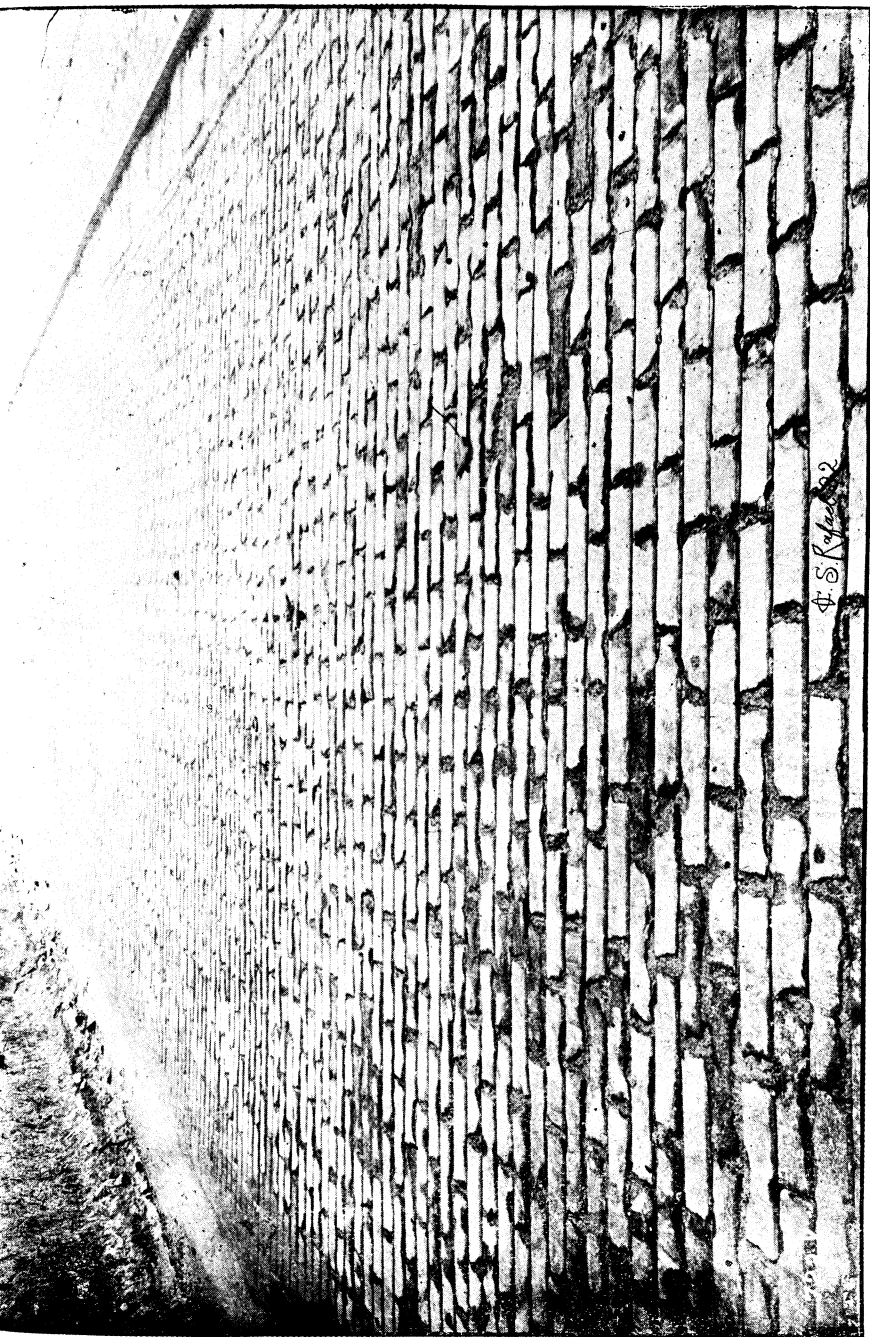
SAMPLE PAVING ON TACON. LAID JULY, 1899. (PHOTOGRAPH TAKEN MAY 5, 1900.)



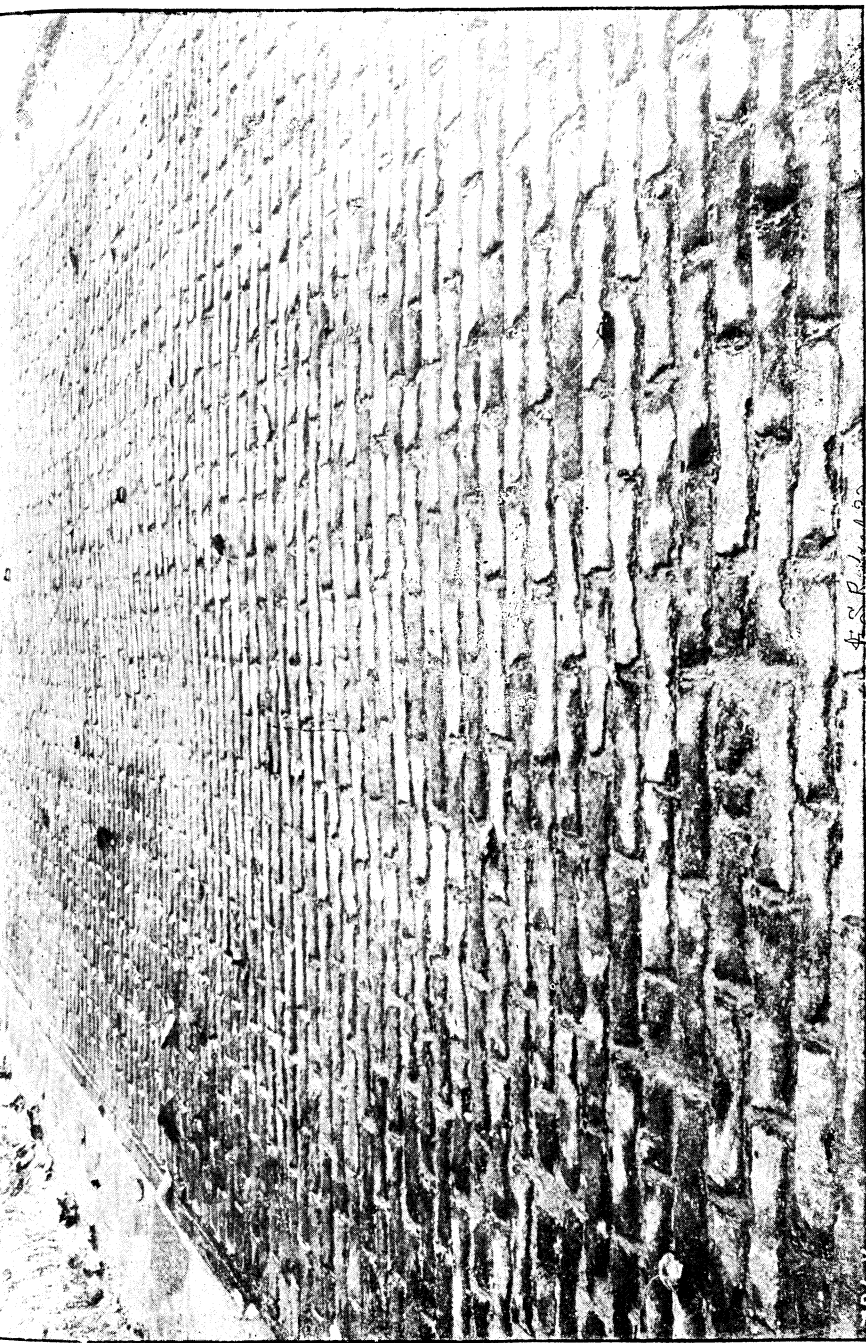
FOUNDATION FOR ASPHALT PAVING IN OBISPO.



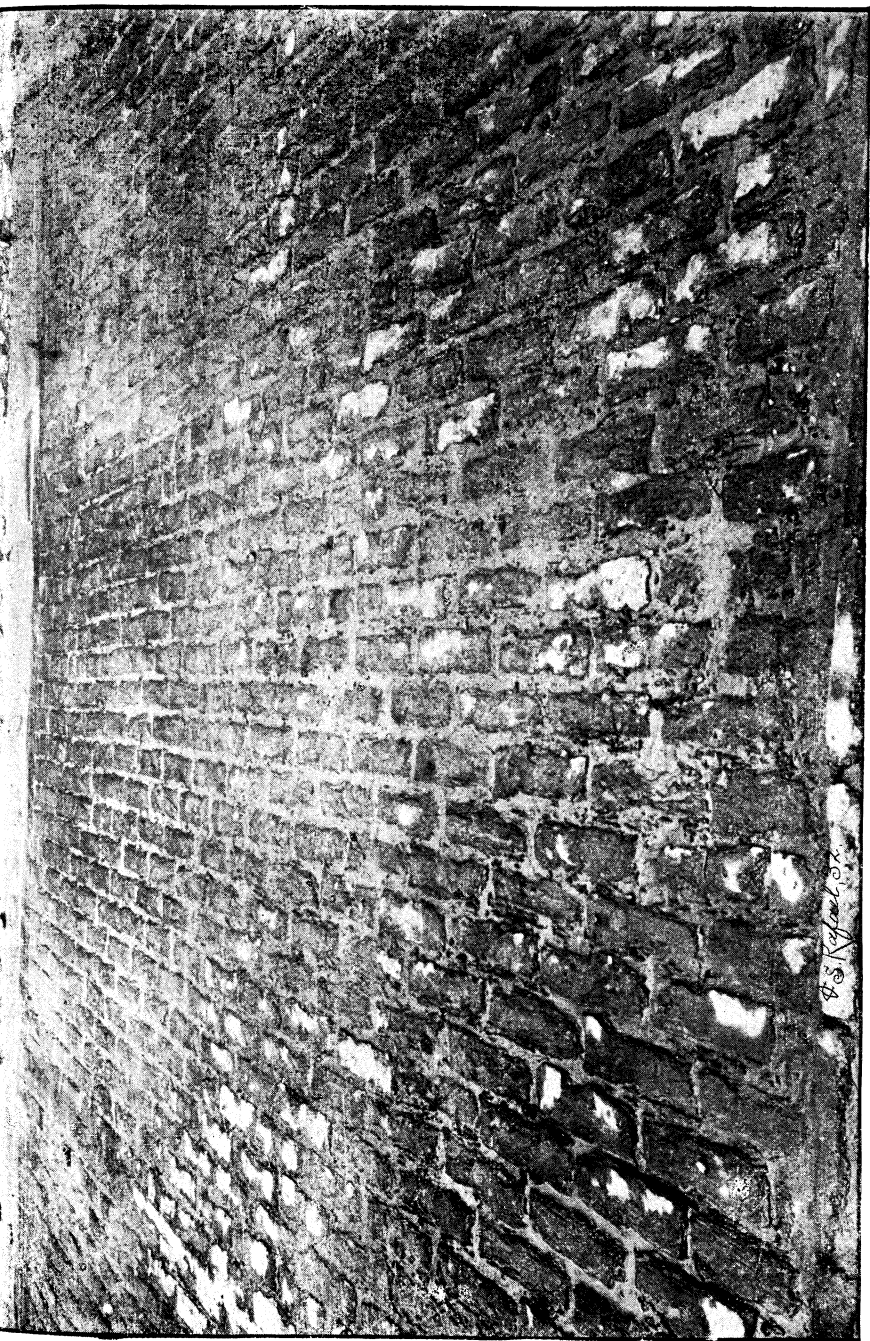
ASPHALT BLOCK. O'REILLY.



MACAVOY VITRIFIED BRICK COMPANY. LAID SEPTEMBER 25, 1899. (PHOTOGRAPH TAKEN MAY 9, 1900.)



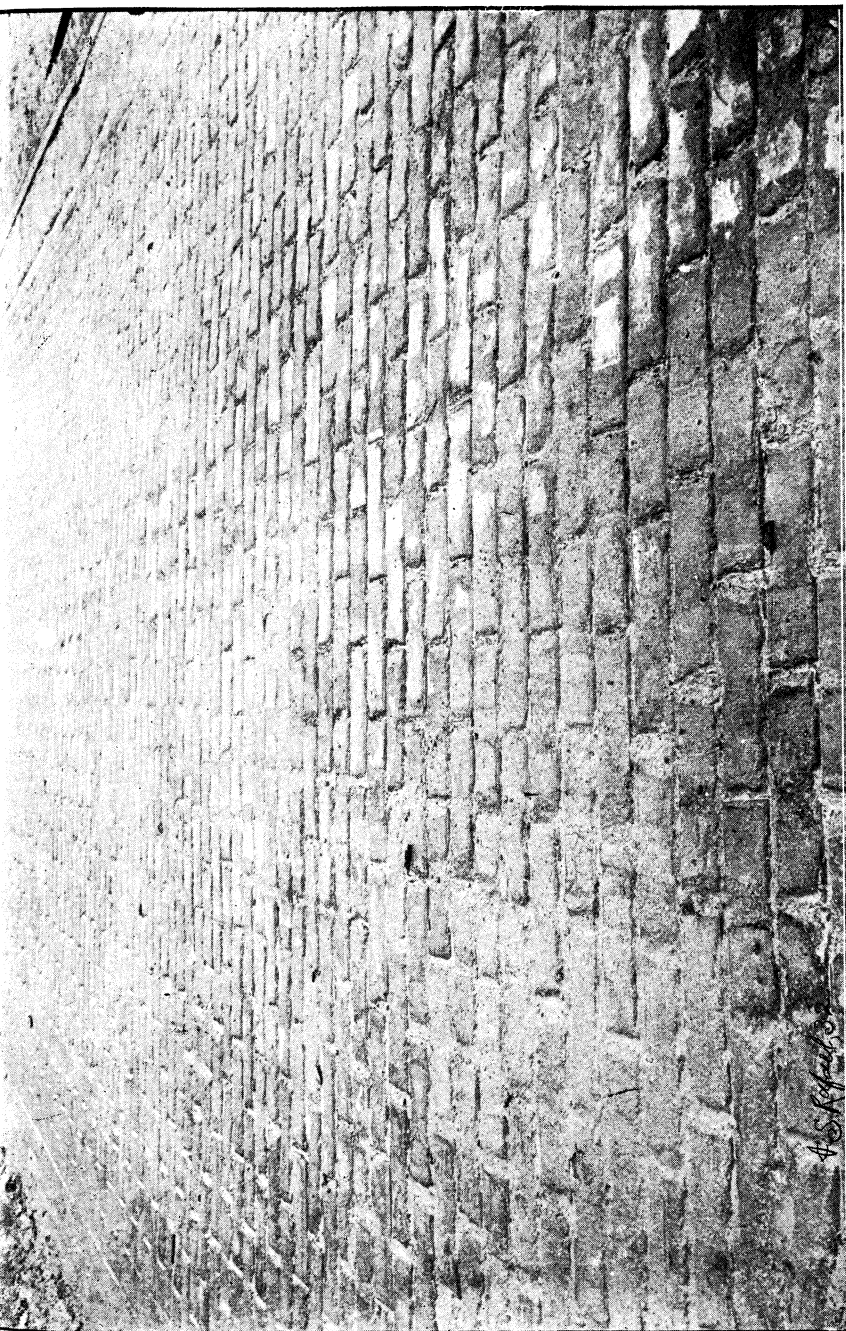
EASTERN PAVING BRICK COMPANY. LAID SEPTEMBER 25, 1899. (PHOTOGRAPH TAKEN MAY 9, 1900.)



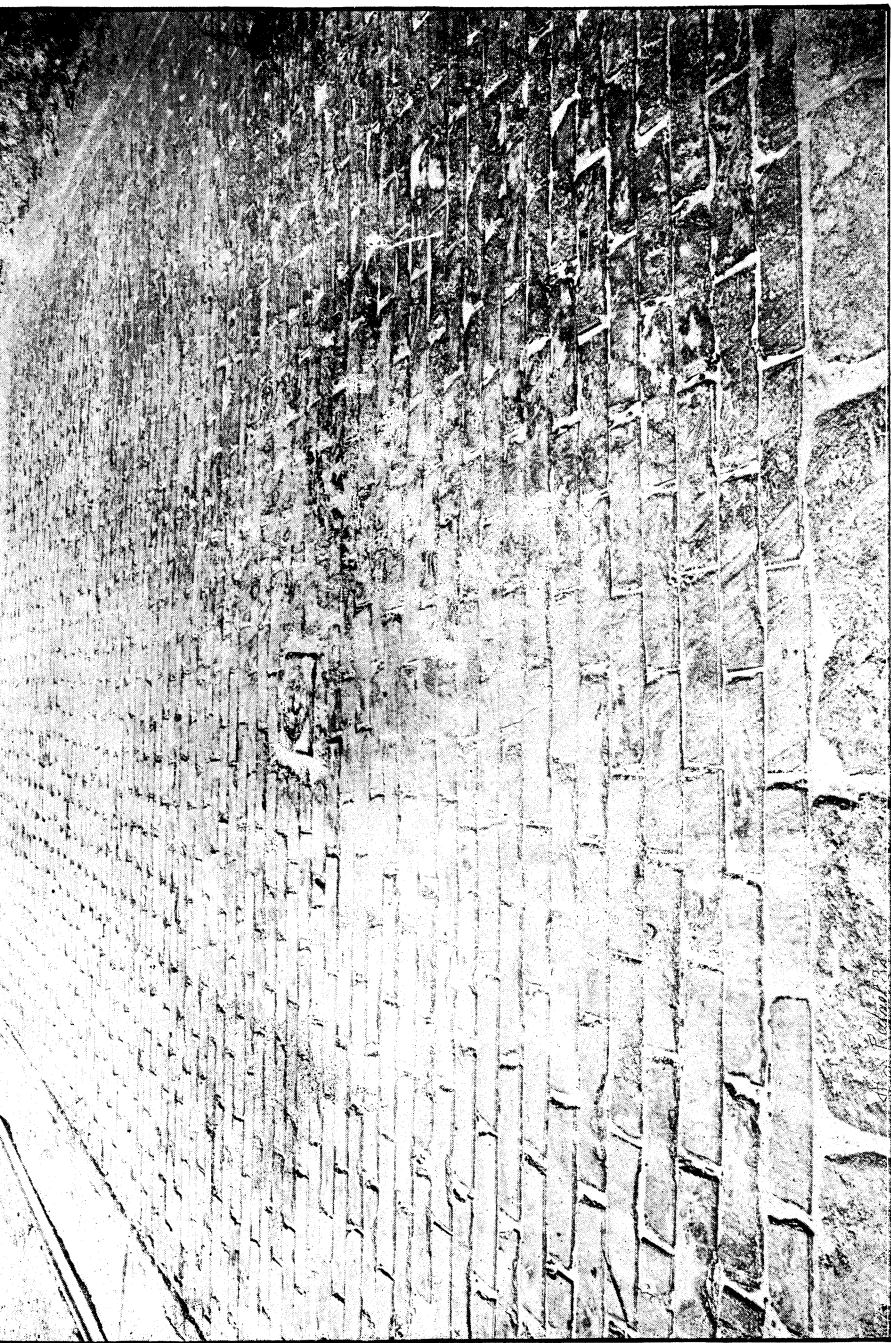
VIRGINIA PAVING BRICK COMPANY. LAID SEPTEMBER 29, 1899. (PHOTOGRAPH TAKEN MAY 9, 1900.)



TENNESSEE PAVING BRICK COMPANY. LAID DECEMBER 4, 1899. (PHOTOGRAPH TAKEN MAY 9, 1900.)



CLEARFIELD CLAY WORKING COMPANY. LAID DECEMBER 4, 1899. (PHOTOGRAPH TAKEN MAY 9, 1900.)



GREEN & HUNTER. LAID DECEMBER 20, 1899. (PHOTOGRAPH TAKEN MAY 9, 1900.)

Statement July 1, 1899, to June 30, 1900, showing expenditures under general objects of work—Continued.

| Department. | Total. |
|--------------------------------------------------------------------------------------------|--------------|
| Repairs to— | |
| Belascoain barracks..... | 2,093.79 |
| Audiencia and carcel | 863.10 |
| Renovation of the beneficencia..... | 32,092.44 |
| Installation at San Jose Asylum of cooking and boiling apparatus..... | 185.22 |
| Repairs to Recogidas prison..... | 4,525.50 |
| Cleaning and whitewashing walls at carcel | 111.00 |
| Operations dredging plant, repairs to wharves and cleaning harbor front ¹ | 106,785.13 |
| Repairs to— | |
| Luz wharf..... | 12,913.11 |
| Dredge Comercio..... | 3,640.30 |
| Dredging Slaughter house Creek..... | 1,617.41 |
| Survey of fortifications | 14,561.28 |
| Grand total..... | 2,585,675.53 |

¹Of the amounts expended for operations of dredging plant, the sum of \$28,003.25 was received from miscellaneous sources, principally from warehouse owners for special work.

PROPERTY DEPARTMENT.

Mr. C. F. Halford, department property clerk, a bonded official, was in charge of this department until September 20, 1899, when his resignation was accepted, and Mr. Beauregard Weber was appointed to the office. Since that time many changes have been made to facilitate and systematize the work and the number of clerks reduced.

The duties of the office are the purchasing of material, tools, etc., used by the engineer department, the storage of the surplus material and property on hand in the department property yard, corner of Trocadero and Monserrate streets, and caring for the property generally.

From July 1, 1899, to June 30, 1900, bills amounting to \$944,482.41 have passed through this office, an average of \$78,706.87 per month. During that period there have been received and purchases made upon 5,762 requisitions. The following method is observed in making purchases:

All larger purchases are made under contract or written agreement, after public notice by advertisement or circular and receipt of bids. Smaller purchases are made in open market, after canvassing for bids, when the necessities of the case require. The assistant in charge of any work submits a project for the work, with estimate. On approval of the project, he submits from time to time requisitions for the materials required, naming prices which he thinks should be paid for the articles, these prices having been obtained in the methods prescribed above. The requisition having been approved by the chief engineer, it is sent to the property clerk, who also endeavors to obtain prices on the articles, and he must purchase them at prices not in excess of those named in the requisition. Should he be unable to obtain prices as satisfactory as these, an explanation must be made and authority granted by the chief engineer before the purchase is made. The materials are ordered from the dealer giving the lowest rates for the best articles, who, upon delivery at the point named in the requisition, receives from the foreman in charge a written receipt. These written receipts are forwarded, with his bill, by the dealer to the property clerk, who checks them and certifies to them, and sends them, together with a copy of the requisition, to the pay department for vouchering and payment. They are again checked in the pay department, and

particular attention is there given to the prices. If everything is correct, the bills are paid. The materials are then charged up to the assistant in charge of the particular work, who is responsible for them, to be disposed of in the usual form upon the property return.

From May 22 until June 26 the pay and property departments were conducted in conformity with the regulations governing the department of public works (Order No. 220, c. s., Division of Cuba); since June 26 the regulations contained in Order No. 249, c. s., Division of Cuba, for the conduct of public works in charge of officers of the United States Army, have been in effect.

DEPARTMENT OF STREETS.

[P. D. Cunningham, assistant engineer, superintendent July 1 to December 31, 1899; W. N. McDonald, assistant engineer, superintendent January 1 to June 30, 1900.]

From July 1 to December 31, the department of streets included the work now embraced in the department of streets, and the department of street cleaning and parks. Report for the whole period is made under existing heads, for the sake of convenience.

As was the case prior to July, 1899, the primary object of all street reconstruction and repair has been to improve the sanitary condition of the city. The lack of a sewerage system has prevented the utilization of funds available in the construction of modern pavement, by reason of the enormous cost which would result from tearing up and replacing such pavement at the time of the construction of a sewerage system; this cost including not only the cost of the pavement, but also the loss to merchants and others using the streets, caused by the total suspension of traffic in the narrow streets while work is in progress.

The noisy character of the old Belgian block and Boston block pavements, covering almost entirely that portion of the city to the eastward of the old city wall, has necessitated the removal of a portion of the old block pavement and the construction of small amounts of modern pavement in the vicinity of certain State office buildings, and a portion of the stone block removed from these locations has been laid upon other streets which were much in need of block pavement.

Endeavor has been made to keep the old stone block pavement in fairly passable condition with a minimum expenditure, but the main work of the department of streets has been in the construction or renewal of macadam pavements.

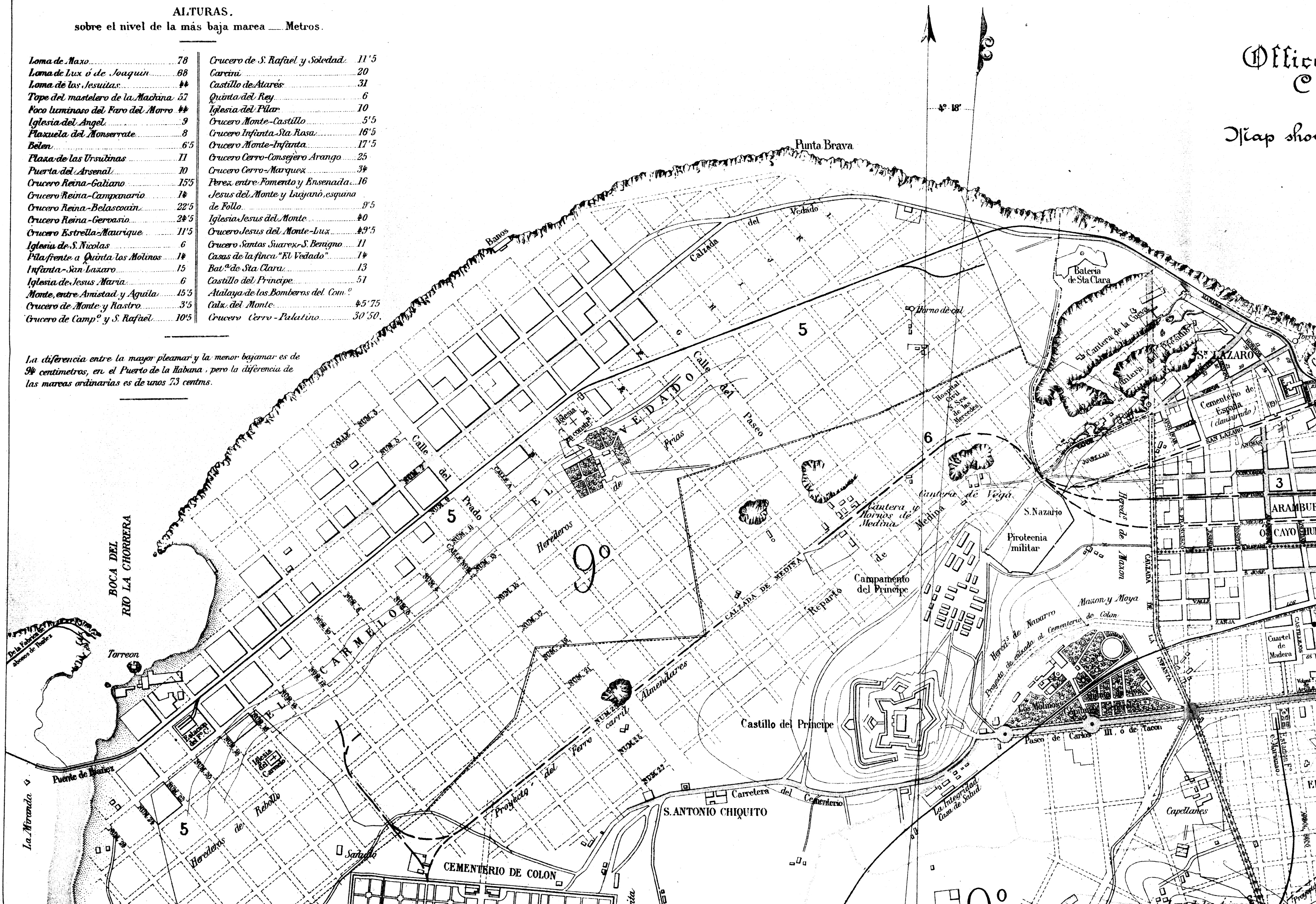
The large force, averaging during the first quarter of the year 105 men per day, employed in patching, taking up and relaying in place Belgian block pavement, was reduced to an average of 33.4 per day for the month of January, and the money previously spent on this work has since been expended on macadam streets, these being then relatively in a more unsanitary condition. The monthly amount of renewal work, exclusive of maintenance work, was increased from 20,000 square meters per month in December to 40,000 square meters in April. In ten months 47 per cent of the macadam streets of the city have been entirely renewed, and nearly all of that portion of the city lying east of Belascoain is provided with good roadways, reducing the traffic on many streets heretofore badly crowded. In addition to this, many miles of fairly good streets have been maintained and 1.5 miles of unpaved streets have been macadamized. Limestone of widely varying character is the only rock adapted to the construction of

ALTURAS.

sobre el nivel de la más baja marea — Metros.

| | | | |
|---------------------------------------|------|-------------------------------------------------|-------|
| Loma de Maxo..... | 78 | Crucero de S. Rafael y Soledad..... | 11'5 |
| Loma de Lux ó de Joaquín..... | 68 | Carcini..... | 20 |
| Loma de los Jesuitas..... | 44 | Castillo de Atarés..... | 31 |
| Tope del mastelero de la Machina..... | 57 | Quinta del Rey..... | 6 |
| Foco luminoso del Faro del Morro..... | 44 | Iglesia del Pilar..... | 10 |
| Iglesia del Angel..... | 9 | Crucero Monte-Castillo..... | 5'5 |
| Plazuela del Monserrate..... | 8 | Crucero Infanta-Sa. Rosa..... | 16'5 |
| Belén..... | 6'5 | Crucero Monte-Infanta..... | 17'5 |
| Plaza de las Ursulinas..... | 11 | Crucero Cerro-Consuegro Arango..... | 25 |
| Puerta del Arsenal..... | 10 | Crucero Cerro-Marquez..... | 34 |
| Crucero Reina-Galiano..... | 15'5 | Perez entre Fomento y Ensenada..... | 16 |
| Crucero Reina-Campanario..... | 14 | Jesus del Monte y Lujano, esquina de Follo..... | 9'5 |
| Crucero Reina-Belascouin..... | 22'5 | Iglesia Jesus del Monte..... | 40 |
| Crucero Reina-Gervasio..... | 24'5 | Crucero Jesus del Monte-Lux..... | 49'5 |
| Crucero Estrella-Maurique..... | 11'5 | Crucero Santos Suarez-S. Benigno..... | 11 |
| Iglesia de S. Nicolas..... | 6 | Casas de la finca "El Vedado"..... | 14 |
| Pila frente a Quinta los Molinos..... | 14 | Bat.ª de Sta. Clara..... | 13 |
| Infanta-San Lázaro..... | 15 | Castillo del Principe..... | 51 |
| Iglesia de Jesus Maria..... | 6 | Atalaya de los Bomberos del Com.º | |
| Monte, entre Amistad y Aguila..... | 15'5 | Calz. del Monte..... | 45'75 |
| Crucero de Monte y Rastro..... | 3'5 | Crucero Cerro-Palatino..... | 30'50 |
| Crucero de Camp.º y S. Rafael..... | 10'5 | | |

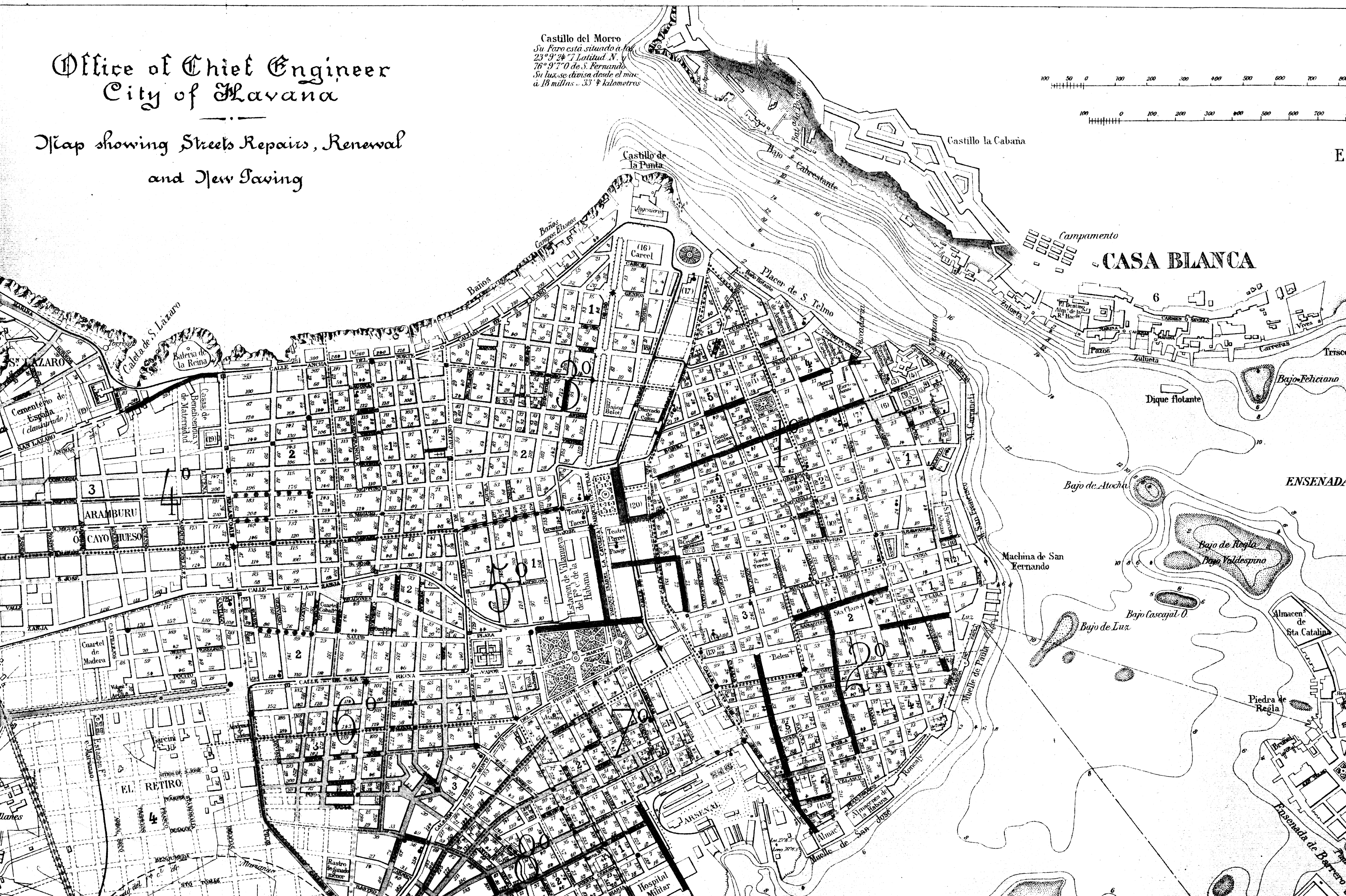
La diferencia entre la mayor pleamar y la menor bajamar es de 94 centímetros, en el Puerto de la Habana, pero la diferencia de las mareas ordinarias es de unos 73 centms.



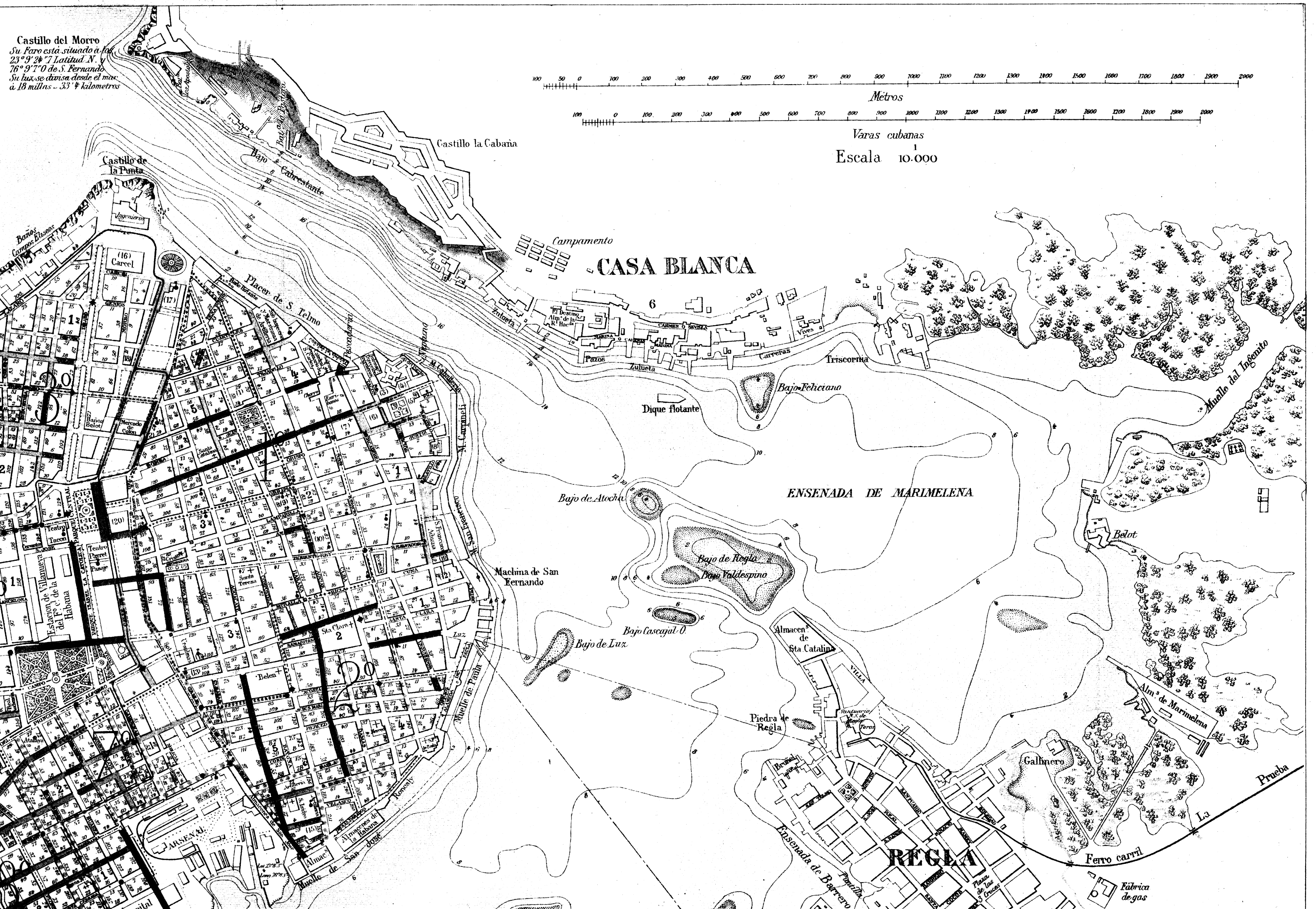
Office
C

Map show

Map showing Streets Repairs, Renewal
and New Paving



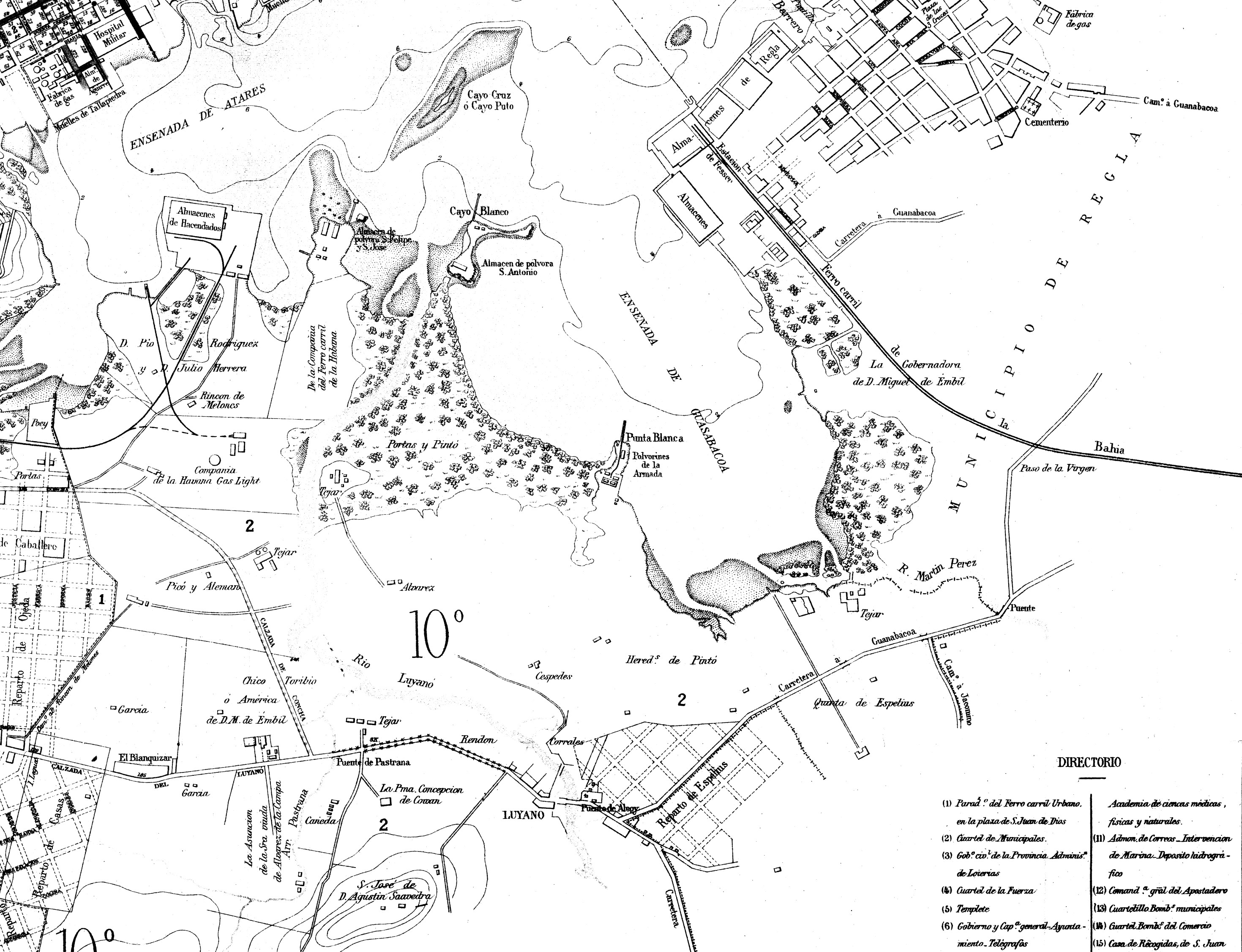
Castillo del Morro
*Su Faro está situado a los
 23° 9' 24" N Latitud N. y
 76° 9' 7" de S. Fernando
 Su luz se divisa desde el mar
 a 18 millas = 33 1/2 kilometros*





PLANO
DE LA
HABANA
POR
D. ESTEBAN T. PICHARDO.





DIRECTORIO

- | | |
|----------------------------------------------------------------------|--------------------------------------------------------------------------------|
| (1) Parada del Ferrocarril Urbano. en la plaza de S. Juan de Dios | Academia de ciencias medicas, fisicas y naturales. |
| (2) Cuartel de Municipales. | (11) Admon. de Correos - Intervencion de Marina. Deposito hidrográ- fico |
| (3) Gob. civ. de la Provincia. Adminis. de Loterias | (12) Comand. a gral del Apostadero |
| (4) Cuartel de la Fuerza | (13) Cuartelillo Bomb. municipales |
| (5) Templo | (14) Cuartel Bomb. del Comercio |
| (6) Gobierno y Cap. general - Ayunta- miento. Telégrafos | (15) Casa de Recogidas, de S. Juan |

HABANA

DE LA

D. ESTEBAN T. PICHARDO,

AGRIMENSOR Y MAESTRO DE OBRAS.

EDITOR: D. JOSÉ VALDEPARES.

Para la formacion de este Plano, se han tenido presentes: el publicado por el Excmo. Ayuntamiento, el del Puerto por los Ingenieros de Obras publicas y otros debidos a los Sres. D. Mariano Carles, D. José Ocampo, D. J. Manuel Alvaro, D. Alberto de Castro, D. Antonio Ariza, D. José Lopez Trigo, D. José C. del Castillo, D. Simon Teja &c; cuyos trabajos ha combinado el Autor del presente, añadiendo los que practicó expreso sobre el terreno.

Las curvas de igual sonda, dibujadas en el Puerto, indican la profundidad del agua de dos en dos metros, en baja mar, y están deducidas del sondeo verificado por O. públicas en 1874.

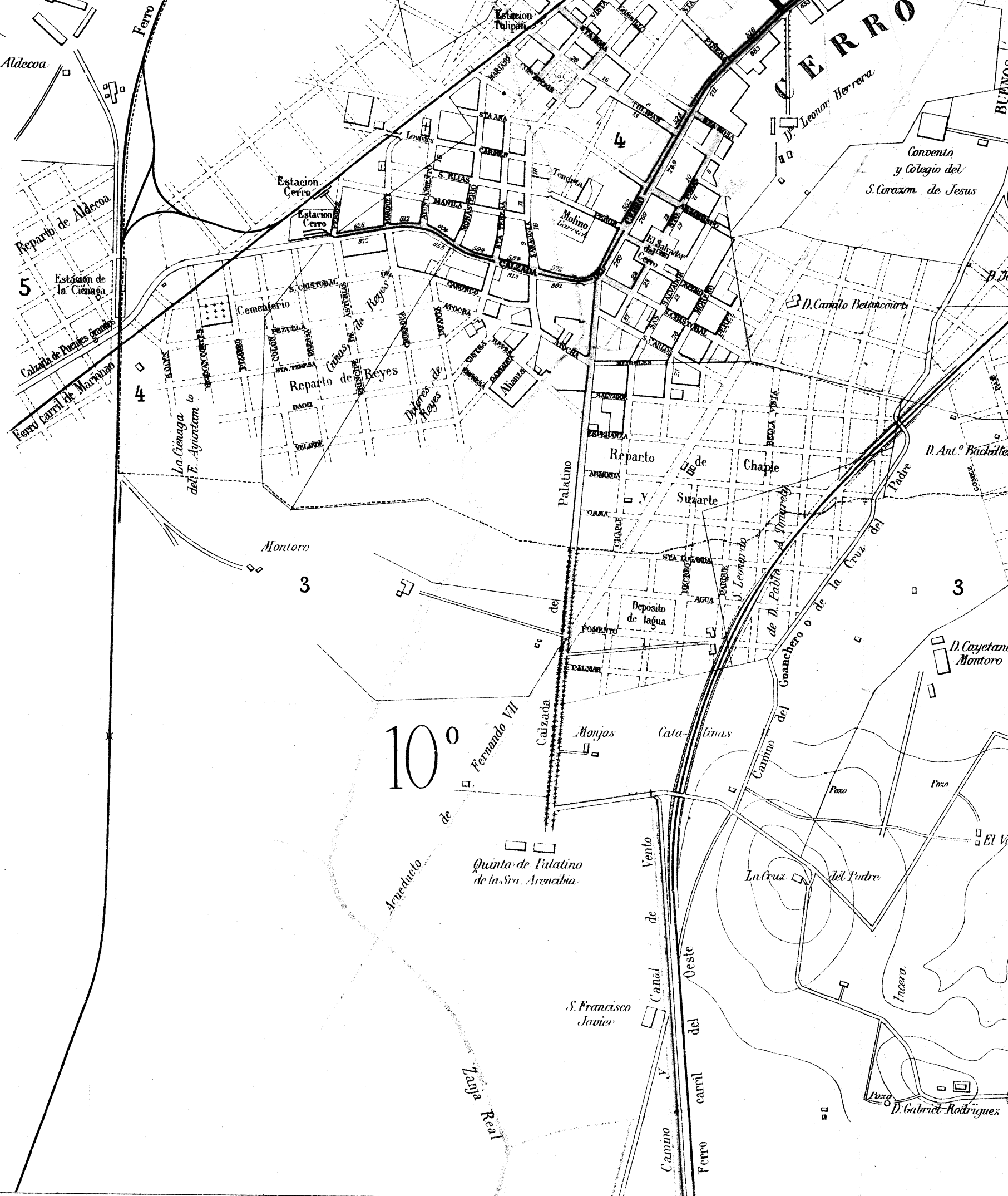
- | | | |
|---------|----------------------------------|------------------------|
| ♣ | Estac. ^{ta} telegrafica | } Servicio de Bomberos |
| ■ | Caja de agua | |
| ✦ | Caja y sifon | |
| ● | Sifon | |
| ————— | Ferrocarril en explotacion | |
| ----- | Idem en proyecto | |
| † | Parroquia | |
| -\|-\|-\|-\| | Limite Municipal | |
| ..... | Idem de Distrito municipal | |
| ----- | Idem de Barrio | |
| +++++ | Idem de Parroquia | |

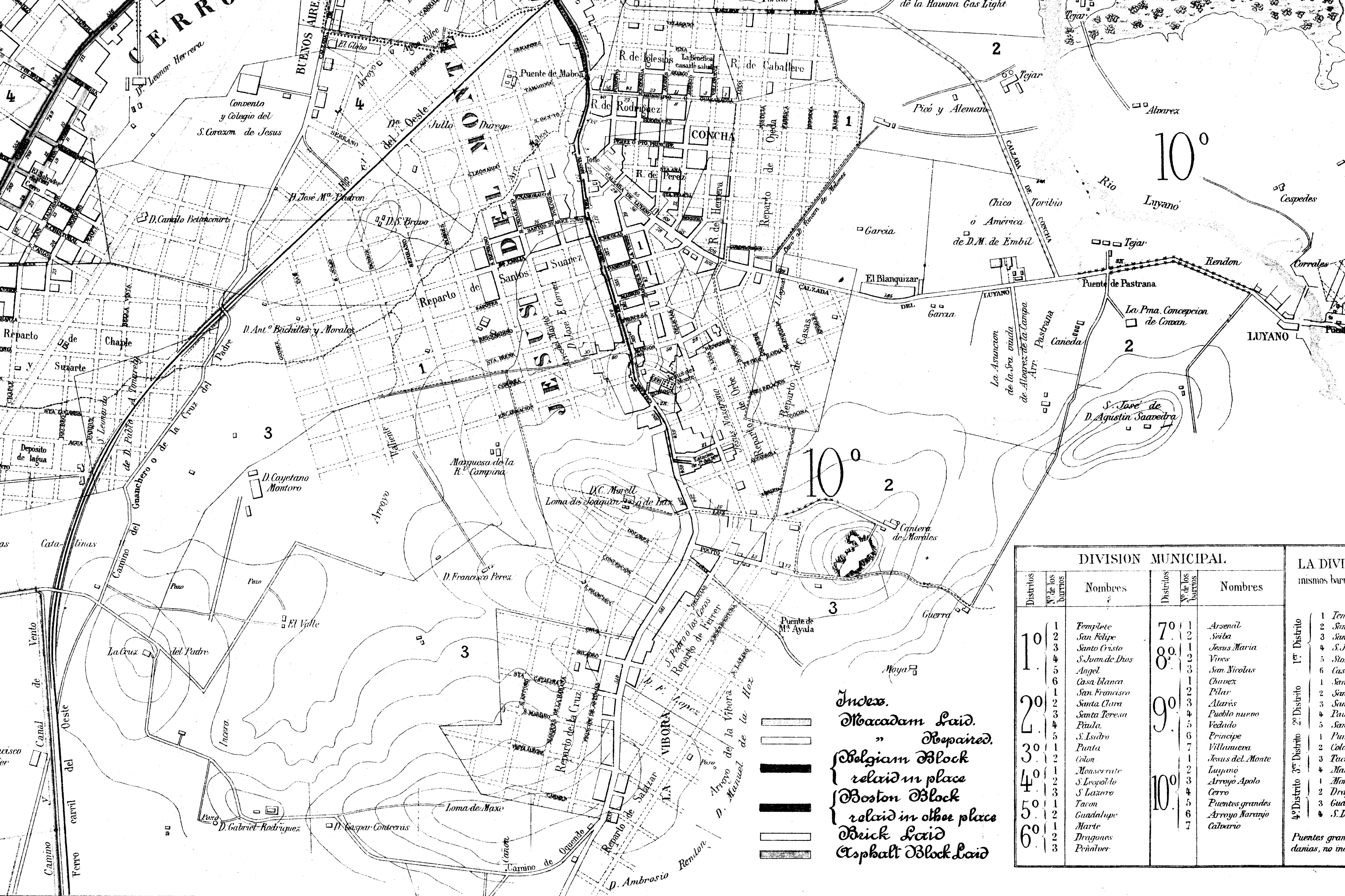
Los números de las casas corresponden al último de cada frente de manzana y están escritos en carácter itálico, como 1,2,3,4

Las que se refieren à la numeracion del Directorio, estan escritas en carácter romanos, y entre paréntesis: (1) (2) (3) (4)

Los ordinales de los Distritos municipales son de carácter capitales y llaman grande: 1^o

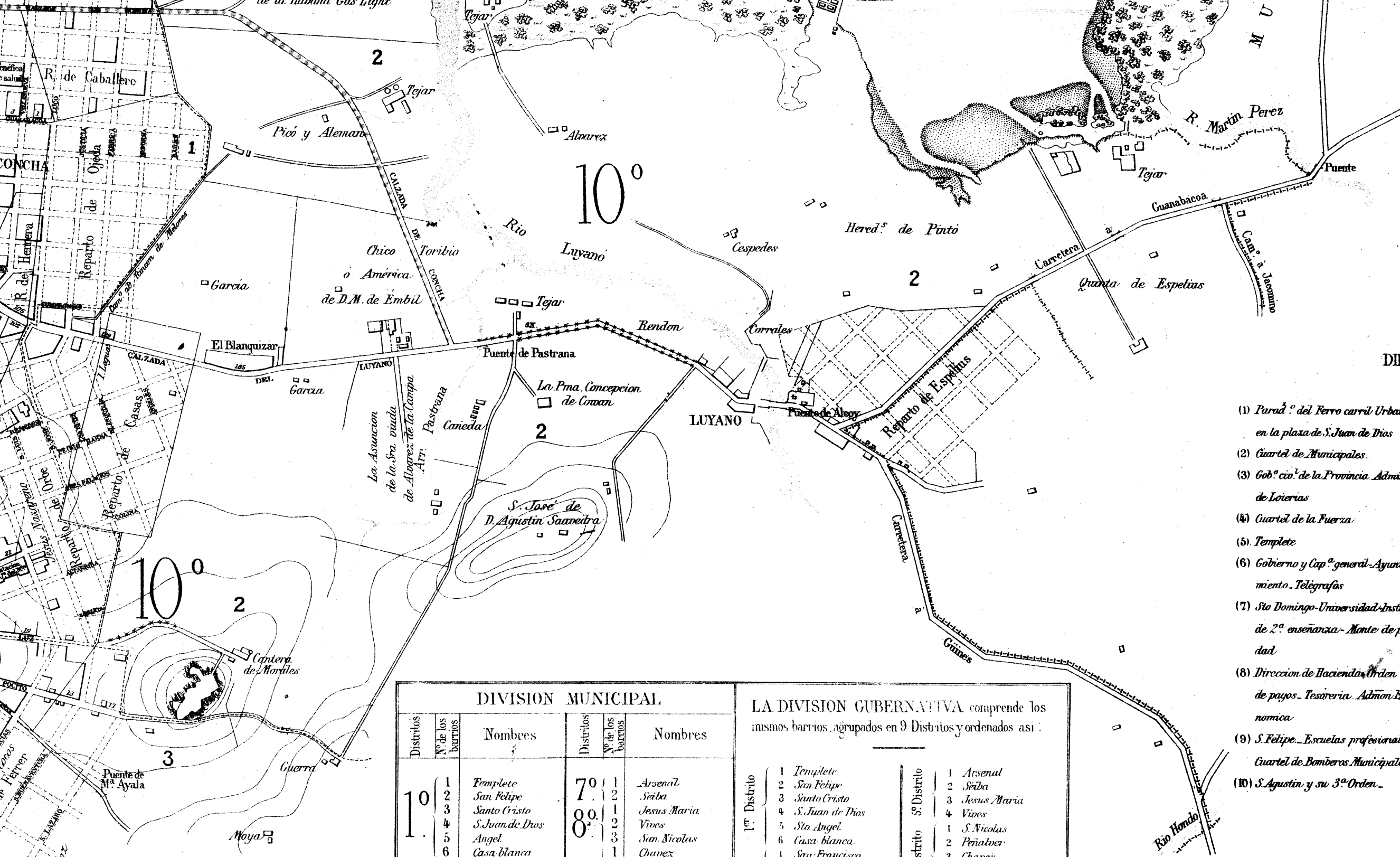
Los de los barrios son de caracter romano, mayores que los del Directorio: 1, 2, 3





| DIVISION MUNICIPAL. | | | | LA DIVISION MUNICIPAL. | | | |
|---------------------|-------------------|-----------------|-----------|------------------------|-----------------|-----------|-------------------|
| Districts | Nº de los barrios | Nombres | Districts | Nº de los barrios | Nombres | Districts | Nº de los barrios |
| 1º | 1 | Templete | 7º | 1 | Arsenal | 1º | 1 |
| | 2 | San Felipe | | 2 | Siaba | 2º | 2 |
| | 3 | Santo Cristo | | 3 | Jesus Maria | 3º | 3 |
| | 4 | S. Juan de Dios | 8º | 1 | Vinos | 4º | 4 |
| | 5 | Angel | | 2 | San Nicolas | 5º | 5 |
| | 6 | Casa blanca | | 3 | Chavex | 6º | 6 |
| | 7 | San Francisco | | 4 | Pilar | 7º | 7 |
| | 8 | Santa Clara | | 5 | Alarés | 8º | 8 |
| | 9 | Santa Teresa | 9º | 1 | Pueblo nuevo | 9º | 1 |
| | 10 | Paula | | 2 | Vedado | 10º | 2 |
| | 11 | S. Isidro | | 3 | Principe | | 3 |
| | 12 | Punta | | 4 | Villanueva | | 4 |
| | 13 | Jesus del Monte | | 5 | Luyano | | 5 |
| | 14 | Monserate | | 6 | Arroyo Apolo | | 6 |
| | 15 | S. Leopoldo | | 7 | Cerro | | 7 |
| | 16 | S. Lazaro | | 8 | Puentes grandes | | 8 |
| | 17 | Tacon | | 9 | Arroyo Narayño | | 9 |
| | 18 | Guadalupe | | 10 | Calvario | | 10 |
| | 19 | Marte | | | | | |
| | 20 | Dragones | | | | | |
| | 21 | Penalver | | | | | |

Index.
 Macadam Laid.
 " Repaired.
 Belgian Block
 relaid in place
 Boston Block
 relaid in other places
 Brick Laid
 Asphalt Block Laid



DIRECTORIO

- (1) Parada del Ferro carril Urbano. en la plaza de S. Juan de Dios
- (2) Cuartel de Municipales.
- (3) Gob. civ. de la Provincia. Adminis. de Loerias
- (4) Cuartel de la Fuerza
- (5) Tempete
- (6) Gobierno y Cap. general. Ayunta. miento. Telégrafos
- (7) Sto Domingo-Universidad-Instituto de 2.ª enseñanza- Monte de piedad
- (8) Direccion de Hacienda-Orden. de pagos. Tesoreria. Admon. Economica
- (9) S. Felipe. Escuelas profesionales. Cuartel de Bomberos Municipales
- (10) S. Agustin y su 3.ª Orden.
- Academia de ciencias medicas, fisicas y naturales.
- (11) Admon. de Corros. Intervencion de Marina. Deposito hidrográfico
- (12) Comand. en jefe del Apostadero
- (13) Cuartelillo Bomb. municipales
- (14) Cuartel Bomb. del Comercio
- (15) Casa de Recogidas, de S. Juan Nepomuceno
- (16) Carcel. Presidio Hospital civil de S. Felipe y Santiago
- (17) Morgue o Necroscopio Obras municipales
- (18) Asilo de S. Jose, de Artes y Oficios
- (20) Teatro de Albizu, o de Llerandi
- Casino español
- (21) Cuartel de la Guardia civil

DIVISION MUNICIPAL.

| Distritos | Nº de los barrios | Nombres | Distritos | Nº de los barrios | Nombres |
|-----------|-------------------|-----------------|-----------|-------------------|-----------------|
| 1º | 1 | Tempete | 7º | 1 | Arsenal |
| | 2 | San Felipe | | 2 | Sibba |
| | 3 | Santo Cristo | 8º | 1 | Jesus Maria |
| | 4 | S. Juan de Dios | | 2 | Vinos |
| | 5 | Angel | 3 | San Nicolas | |
| | 6 | Casa blanca | 1 | Chavez | |
| 2º | 1 | San Francisco | 2 | Pilar | |
| | 2 | Santa Clara | 9º | 3 | Alarés |
| | 3 | Santa Teresa | | 4 | Pueblo nuevo |
| | 4 | Paula | | 5 | Vedado |
| | 5 | S. Isidro | | 6 | Principe |
| 6 | Punta | 7 | | Villanueva | |
| 3º | 1 | Colon | 10º | 1 | Jesus del Monte |
| | 2 | Monserate | | 2 | Luyano |
| 4º | 1 | S. Leopoldo | | 3 | Arroyo Apolo |
| | 2 | S. Lazaro | | 4 | Cerro |
| | 3 | Tacon | | 5 | Puentes grandes |
| 5º | 1 | Guadalupe | 6 | Arroyo Naranjo | |
| | 2 | Marte | 7 | Caballero | |
| 6º | 1 | Dragones | | | |
| | 3 | Penalver | | | |

LA DIVISION GUBERNATIVA comprende los mismos barrios, agrupados en 9 Distritos y ordenados así:

| | | | | | |
|-------------|---|-----------------|-------------|-------|-----------------|
| 1º Distrito | 1 | Tempete | 5º Distrito | 1 | Arsenal |
| | 2 | San Felipe | | 2 | Sibba |
| | 3 | Santo Cristo | | 3 | Jesus Maria |
| | 4 | S. Juan de Dios | | 4 | Vinos |
| | 5 | S. Angel | | 1 | S. Nicolas |
| | 6 | Casa blanca | | 2 | Penalver |
| 2º Distrito | 1 | San Francisco | 6º Distrito | 3 | Chavez |
| | 2 | Santa Clara | | 4 | Pilar |
| | 3 | Santa Teresa | | 5 | Alarés |
| | 4 | Paula | | 1 | S. Lazaro |
| 3º Distrito | 1 | San Isidro | 7º Distrito | 2 | Pueblo nuevo |
| | 5 | Punta | | 3 | Principe |
| | 2 | Colon | | 4 | Vedado |
| 4º Distrito | 3 | Tacon | 8º Distrito | 1 | Jesus del Monte |
| | 4 | Marte | | 2 | Luyano |
| | 1 | Monserate | | 3 | Arroyo Apolo |
| | 2 | Dragones | | 1 | Villanueva |
| | 3 | Guadalupe | 2 | Cerro | |
| | 4 | S. Leopoldo | | | |

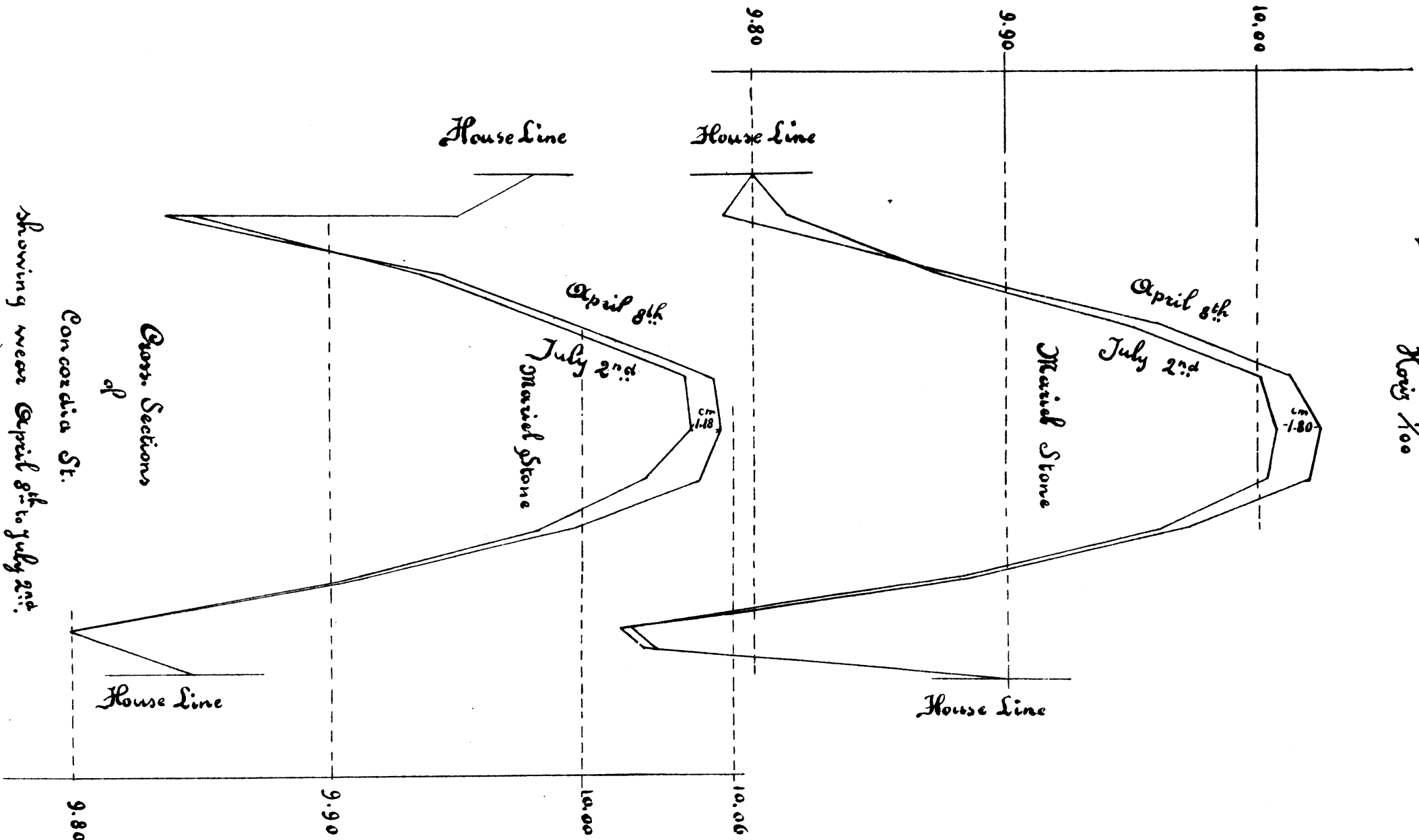
Puentes grandes, Arroyo Naranjo y Caballero estaban como Penales, no inclusas en los 9 Distritos.

Puentes grandes, Arroyo Naranjo y Calvario estaban como Pedanias, no incluidas en los 9 Distritos.

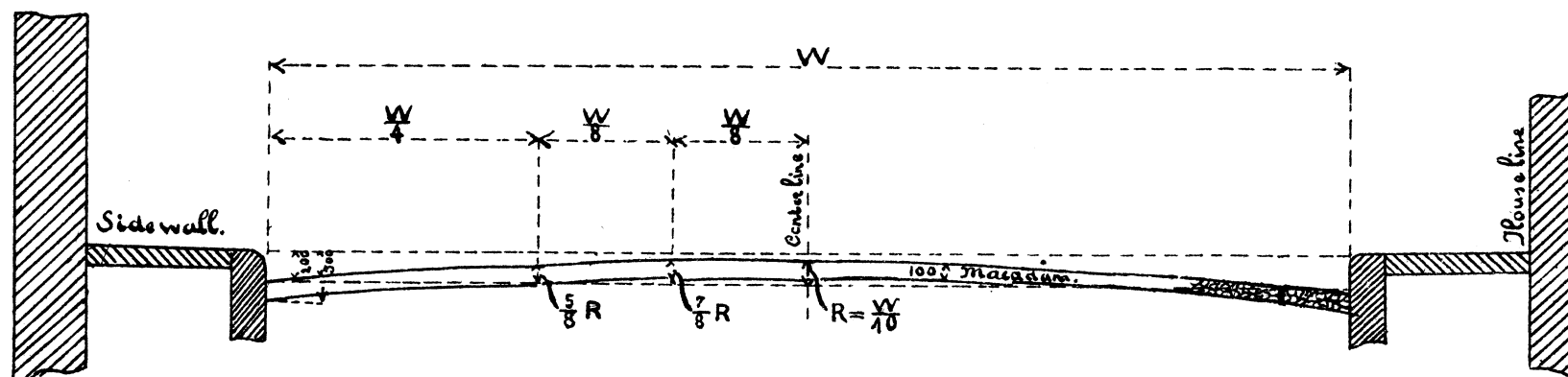
Office of Chief Engineer
Division of Cuba.
To accompany Report of June 30th, 1900.
W. M. Clark
Major Corps of Engineers, U.S.A.
Chief Engineer Division of Cuba.

Index.
Macadam Laid.
" Repaired.
Belgian Block
relaid in place
Boston Block
relaid in other place
Brick Laid
Asphalt Block Laid

Scales
Vert. $\frac{1}{20}$
Horis. $\frac{1}{100}$



Standard Cross Section
for Macadam Streets with curbs.

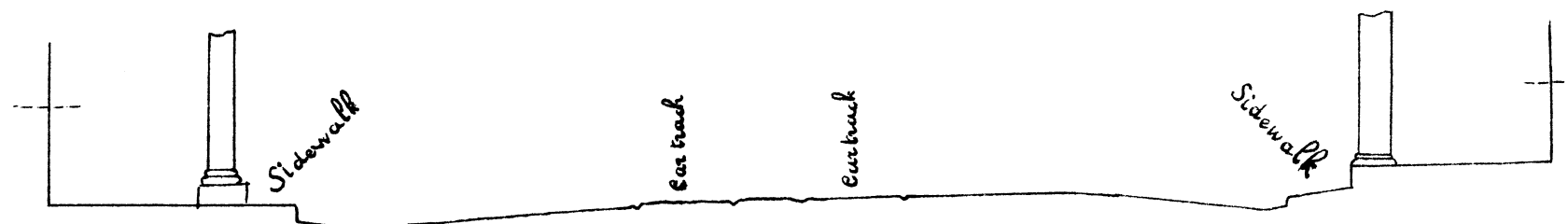


Note: W = Width.
 R = Total Rise.

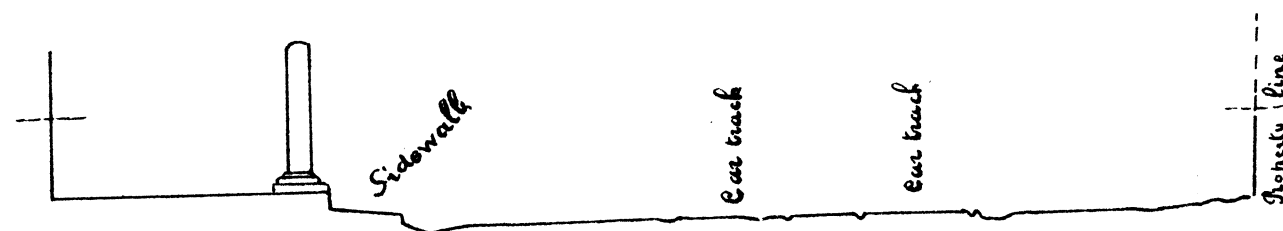
Scale $\frac{1}{40}$ 37:12



Virtudes Between Prado and Zulueta.



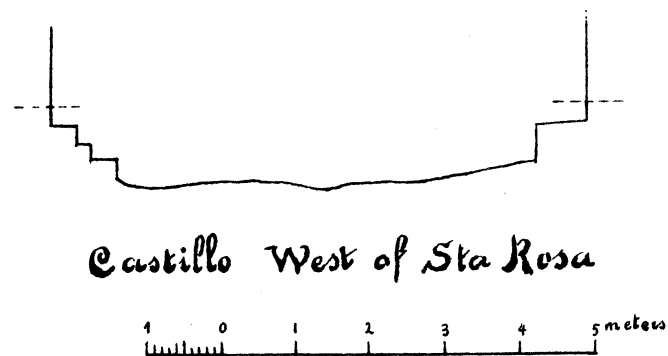
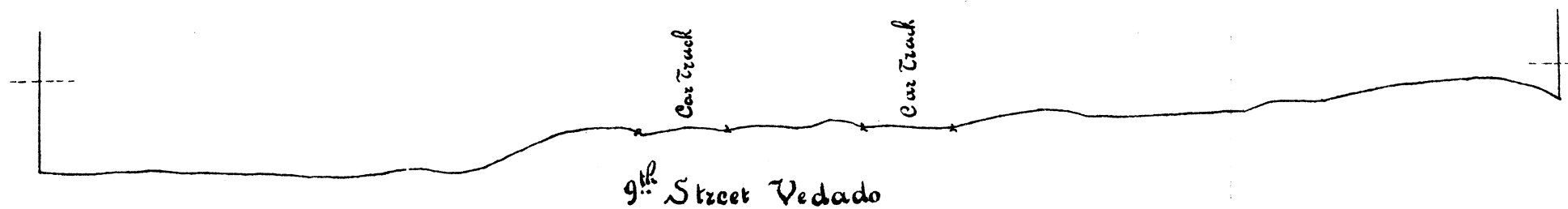
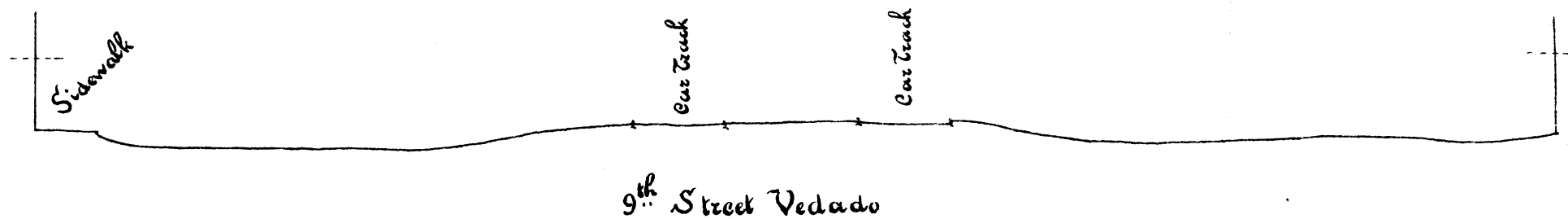
Cerro #504.



Corro #446.

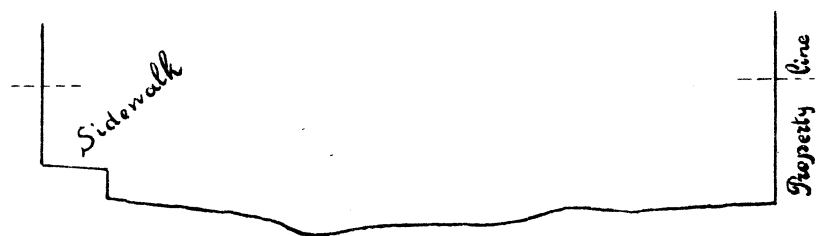
1 2 3 4 5 meters

Plate n° 74



1 0 1 2 3 4 5 meters

Plate n° 15.



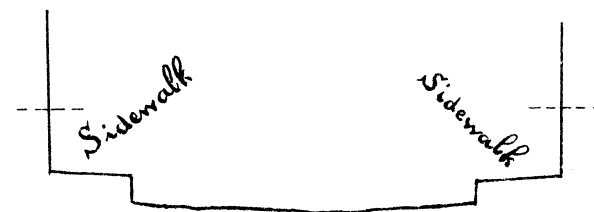
Espada, between San Miguel and Neptuno



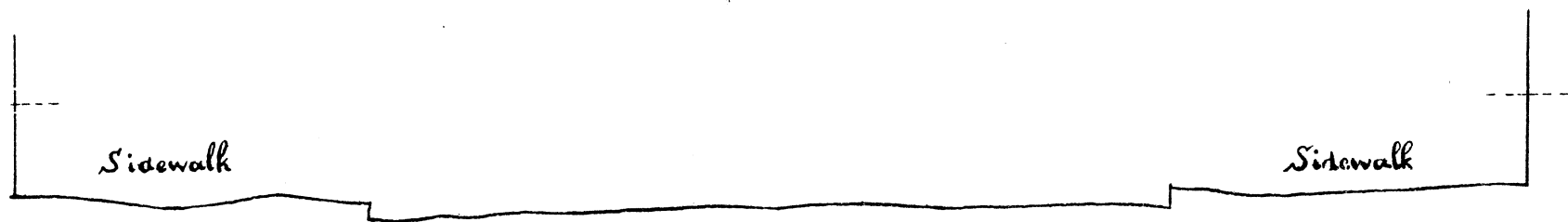
Soledad, about 5^m N. from Neptuno.



Marques Gonzalez 5^m N. from San Miguel.

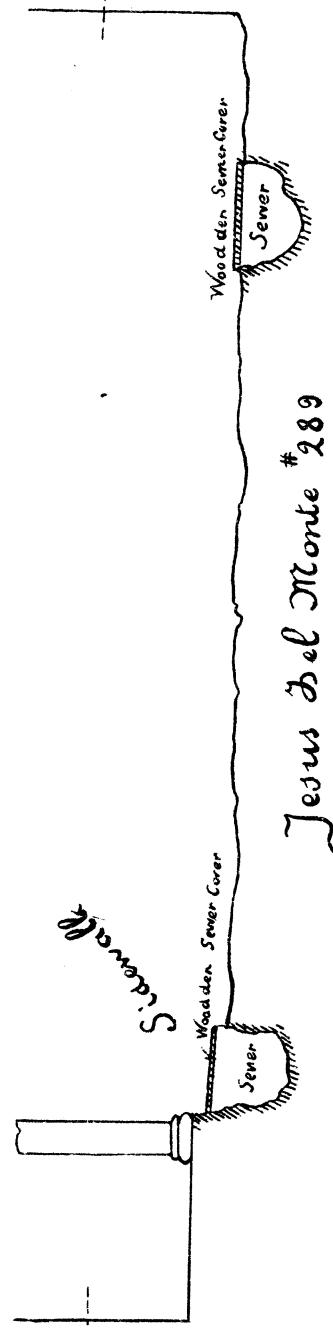
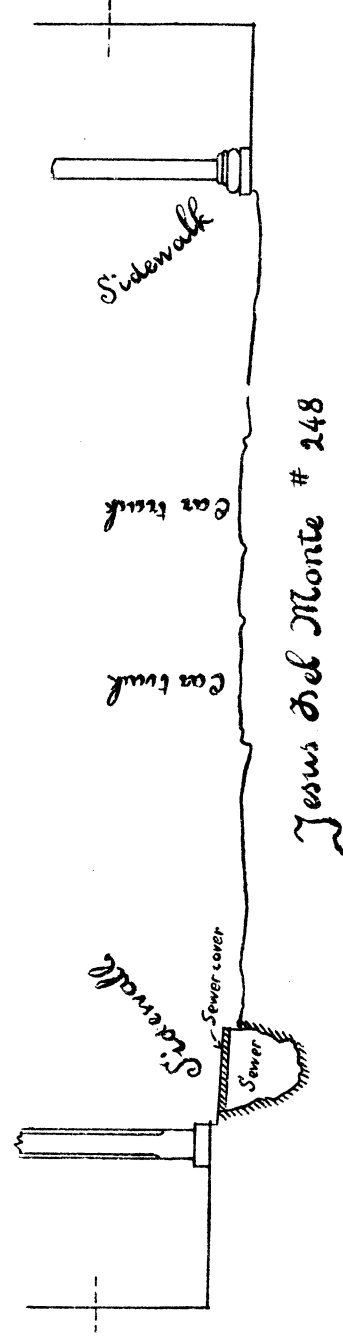
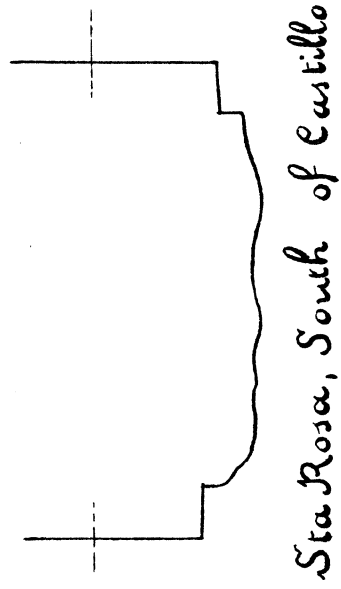


Crespo, between Virtudes and Animas



Belascoain front of #30.

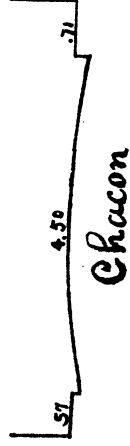




1 0 1 2 3 4 5 meters

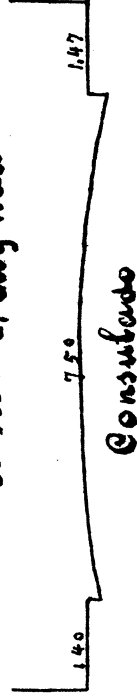
Plate No 17.

Typical section of Street
inside of City wall

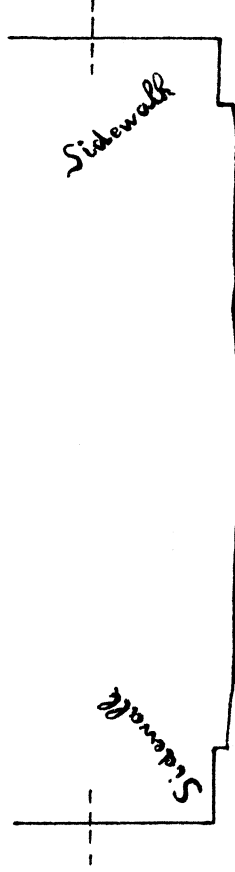


Chacon

Typical section of Streets
outside of City wall



Consulado

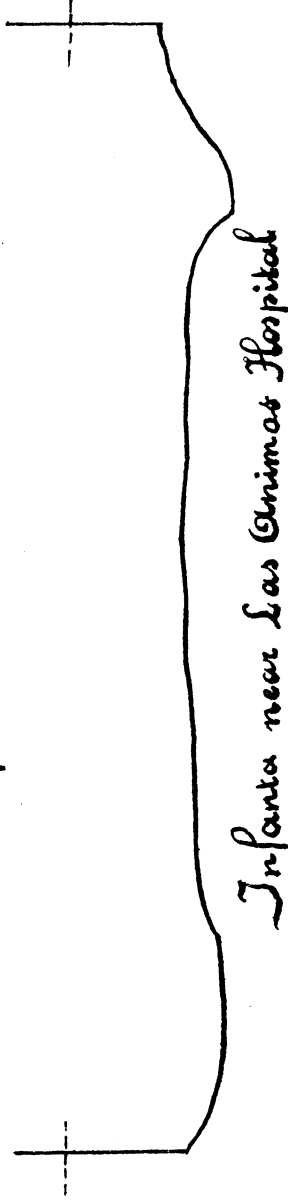


Intersection of Maloja and Manaque
from SW to SE corner.



Intersection of Maloja and Marisque

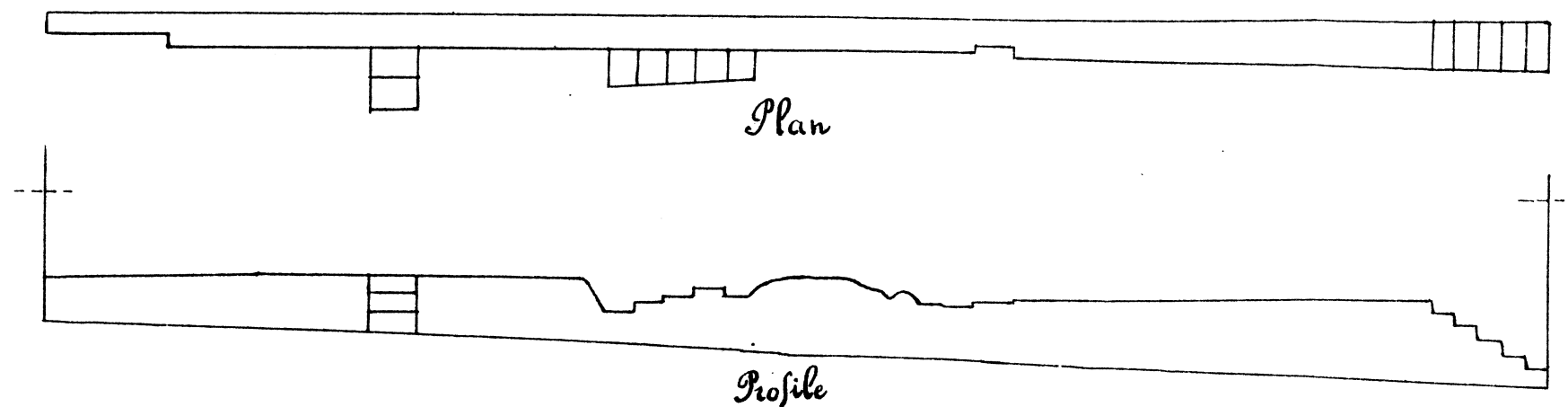
from S.E. to N.W. corner



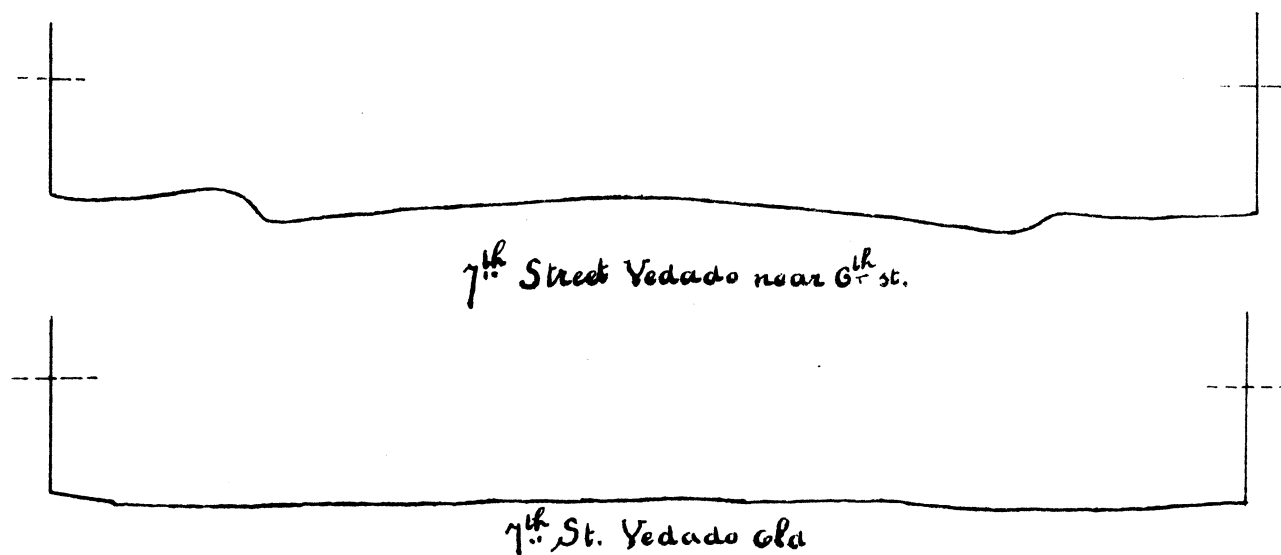
Infanta near Las Animas Hospital



Plate N° 18.



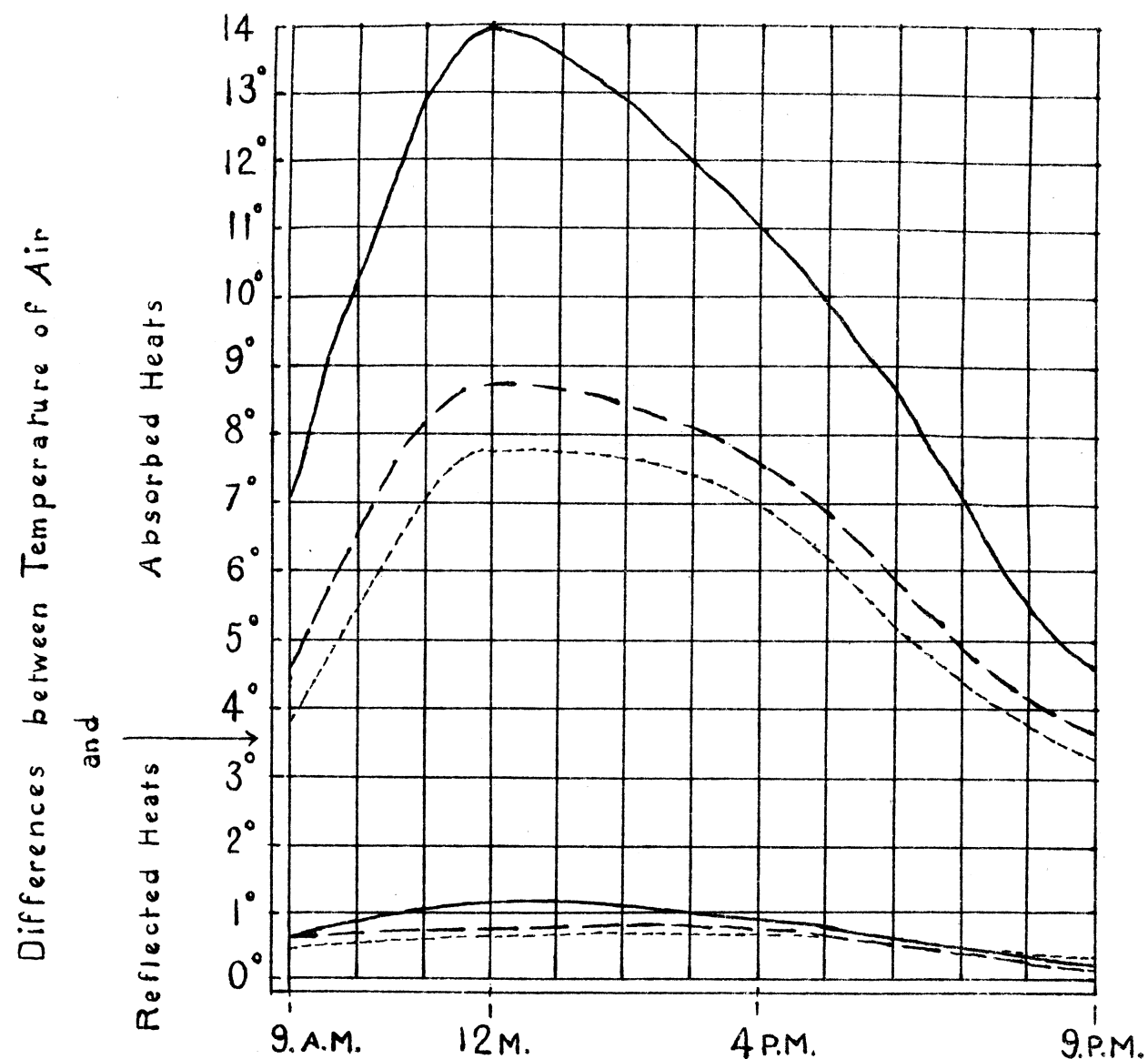
Plan and Profile of Sidewalk on San Joaquin.



0 1 2 3 4 5 meters

Plate n° 19

The Differences between Temperatures of Au and both Absorbed and Reflected Heats at 9 A.M.; 12 M.; 4 P.M.; and 9 P.M.



Designation

for Sheet Asphalt

" Asphalt Block

" Vitrified Brick



Measurements were taken
in

HAVANA CVBA

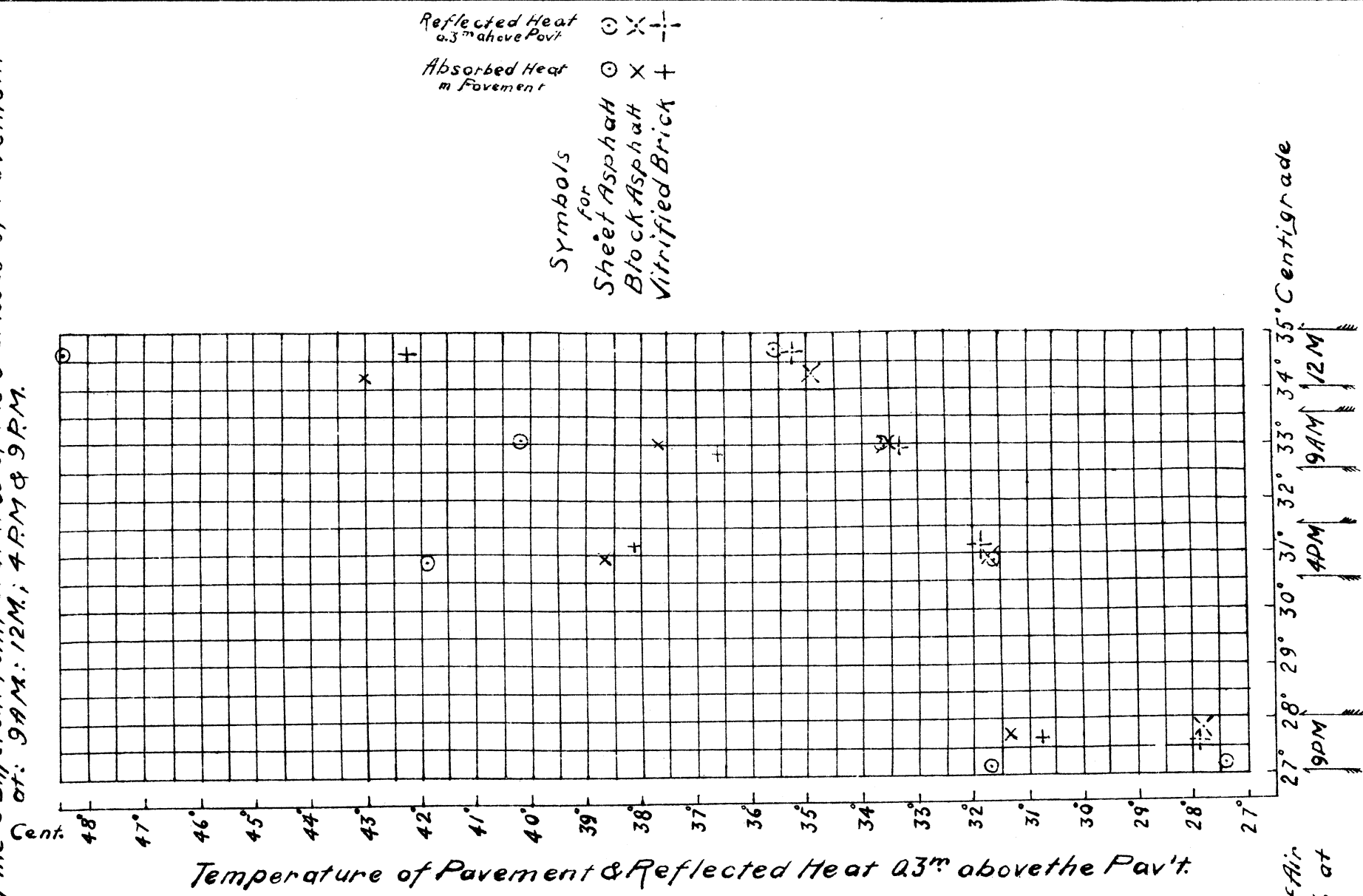
July 16th to 27th 1899

Plate No 24.

CHART SHOWING EFFECT OF SUN

VITRIFIED BRICK, BLOCK & SHEET ASPHALT PAVEMENTS
 From temperature measurements taken in the pavements & 0.3m above them
 The heat of the air was measured at a point 2.4m above the pavement by a thermomometer shaded from the reflected heat.

The Averages of the 3 Different Temperatures of the 3 Classes of Pavement
 at: 9 AM, 12 M, 4 PM & 9 PM.



Note - The Number of Degrees of Absorbed or Reflected Heat is found directly opposite the Absorbed or Reflected Heat Symbol, on the Ordinate

The Number of Degrees of Heat in the Air 2.4m above the Pavement, and the Hour when Temperature Measurement was taken are found directly under the Symbol, on the Abscissa.

macadam roadways that has so far been discovered in the vicinity of Habana.

Great difficulty has been experienced in obtaining stone, in sufficient quantity, by contract or in open market. This trouble has largely arisen from failures to properly install stone crushing plants. During March and April, however, the department was able to purchase as much stone as funds in hand would permit. A blue limestone from the "Martin-Mesa" quarry, near Mariel, has been procured in small quantity and laid upon a portion of San Rafael street. In prolongation of this, the street is paved with stone from Vento water works tract in order that a comparison of wear and cost may be obtained.

Arrangements have been completed for obtaining another limestone from Matanzas, which appears to be of better quality than any in the local market. Effort is being made to bring granite from Santiago at a reasonable price, but so far the arrangements have not been completed.

The lack of a sewerage system, already mentioned, has necessitated the laying of macadam pavements upon streets having traffic too great in volume and too severe in character to be borne by such a pavement, and upon some of these streets it has been necessary to keep a small maintenance gang.

Until December, 1899, the price paid for broken stone, delivered at such points upon the streets of Habana as were designated by the department, was \$2.70 U. S. currency per cubic meter. Since that time it has been reduced to \$2.30 and \$2.35 per cubic meter.

Stone inspectors are stationed at the various railway depots where stone is loaded from trains to carts and they are required to make careful measurement of each cart load of stone and give directions to the drivers as to point of delivery. The results of these measurements are turned in daily to the superintendent of the department. The foremen at the points of delivery are also required to make careful measurement of the stone, and to receipt to the cart driver for the amount contained in each cart load. Record in every case is made of the cart numbers. The receipts given by the foremen at points of delivery must in every case accompany the bills for the stone, and these bills must agree with the receipts and also with the records of the stone inspectors. The stone inspectors at frequent intervals are changed from one station to another.

The drivers of all carts employed in the work of the department are furnished each morning with a check punched by the superintendent of the city stable, in case the cart is owned by the department, and by the superintendent of transportation, in the case of a hired cart, which shows the ownership of the cart. Upon this check, and the stub retained by the issuer, are punched the time of starting to work. All foremen of gangs and superintendents of dumps are provided with numbered punches, and time of arrival and departure of every cart is punched by these foremen and superintendents. In the case of carts owned by the department, these checks are turned in at the conclusion of the day's work to the superintendent of the city stable. In case of hired carts, these checks are submitted by the owner, with his bills, which must agree with the checks. This system of checking is used throughout the engineer department.

The amount of work done in the reconstruction of old macadam streets has so varied that it is difficult to give, in a general expression, the cost per square meter of such renewal. It has varied from

45 cents per square meter to \$1.25 per square meter, this variation depending entirely upon the amount of grading necessary to bring the subgrade to a proper cross section. The average cost of renewing streets, such as are shown on Plates 7, 8, and 9, has been 80 cents per square meter. Work such as that shown on Plate No. 10, where the road was practically obliterated and ditches filled up, has cost \$1.33 per square meter.

The new macadam streets built have cost, exclusive of sidewalks and curbing, from 60 cents to \$1.32 per square meter. One of the most important constructions in macadam was the extension of the Calzada de la Infanta across the quarry beds near the north end of that thoroughfare. The average depth of fill was about three meters and the cost of this work per square meter was \$4.68. The average cost of macadam patching has been 35 cents per square meter.

A number of important thoroughfares, among them the north end of the Prado, Belascoain Street and Calzada de la Infanta, have been maintained by patching the holes formed by traffic. In all cases the holes have been carefully cut out in order to obtain a thorough bond, but this character of maintenance for streets which are without a fair covering of metal is not satisfactory. Its continuance, in some instances, upon streets which had become worn practically to the foundation stone, has been a matter of necessity.

During the fiscal year one 10-ton street roller was purchased, making a total of five adapted to macadam work (four of 10 tons, one of 15 tons), besides which the department has had a small sheet asphalt roller which has been of considerable value in rolling park walks. Two of the five above-mentioned rollers have been in service in Cuba for fourteen years. Since they were practically rebuilt by the department these machines have given more satisfactory results than any of the more modern machines so far obtained.

The intersections of narrow macadam streets have here, as elsewhere, given difficulty because of the necessity of carrying the drainage along one across the other. This has been accomplished until recently by the construction of flat ditches, one upon each side of the street which required continuous direct drainage. In the latest work, instead of constructing two flat drains, the street crossed has been lowered in its entire width to the level of the gutters of the intersecting street, with the result that the wear at intersections has been very much lessened.

In the cross sections adopted for macadam work the standard height of crown above gutters has been made one-fortieth of the total width between curbs. In work during the current calendar year this crown has been increased in some instances to one-thirtieth of the total width between curbs, with quite satisfactory results.

The concentration of traffic upon the narrow streets, and consequent very rapid wear upon the middle third of the street surface, has in some instances reduced the transverse slope of macadam roads very much below the degree desirable for perfect drainage, and in some recent work the cross section used was a parabolic arc, the maximum curvature being at the street center.

Rotten cementitious limestone, calcareous sand and screenings of the quarries from which macadam stone has been obtained have all been used as binding materials. The most satisfactory result has been obtained from quarry screenings, but it has not been practicable

to obtain this product in sufficient quantity to use it to the exclusion of the others.

The joints between macadam and block pavement have been very difficult of maintenance, in spite of the fact that the macadam surface has been built several inches above the block pavement grade at such joints. Upon the Calzadas del Cerro and Jesús del Monte it has not been found possible to maintain the macadam surface alongside the street car tracks. It has been made more difficult here than is usually the case, by the great flatness and width of the tramway rails, and the consequent tendency of the traffic to follow these rails, with frequent turnings off and on, which has subjected the macadam to a grinding effect immediately alongside the rail.

The necessity of thorough sprinkling, at frequent intervals, of macadam construction has been forcibly demonstrated in the work here, the sprinkling plant having been so limited as to prevent as thorough attention as was desired to some of the macadam roadways.

At the beginning of May, the principal streets of the thickly settled portion of the city being in good condition with respect to sanitation and fitness for traffic, orders were received to close up all work of macadam construction and reconstruction and to direct the energy of the department of streets to the maintenance of streets already repaired. In compliance therewith the force employed during the month of June was reduced to a little more than half its previous number. Effort has been made to preserve the nucleus of a full organization and retain in minor positions, at smaller pay, those employees whose conscientious effort had resulted in their gradual promotion from the grade of laborer to positions of responsibility.

The following table shows the general results of the macadam work in the city during the fiscal year:

| | Lineal meters. | Square meters. | Lineal miles. |
|----------------------------------|-------------------|-------------------|------------------|
| Macadam renewals..... | 46,041 | 346,362 | 28.61 |
| Unpaved streets macadamized..... | 2,720 | 20,998 | 1.69 |
| Macadam repairs..... | | 170,618 | |

| | |
|-----------------------------------|-----------|
| Daily average force employed..... | 371.78 |
| Cubic meters stone used..... | 82,572.89 |
| Steam rollers employed..... | 5 |
| Ox rollers employed..... | 1 |

VENTO STONE CRUSHING PLANT.

There was put in operation about May 1 a stone crushing plant at Vento. Stone from this quarry has already been placed on the streets in comparative test with other stone from Mariel. The capacity of the plant is 200 meters of crushed stone per day, and in addition the macadamizing work will require 100 meters of foundation stone daily, which will be brought from these quarries.

A modern plant has been erected, and it is hoped that it will prove an economical solution of the stone question for the city. Great trouble has been experienced by the irregularity of the delivery of stone on the part of the contractors.

Laborer's houses and office buildings were built, as there is practically no settlement within two miles of this location.

BELGIAN AND BOSTON BLOCK.

This class of pavement is laid almost entirely in the business portion of the city. The Belgian blocks are irregularly shaped, measuring about 6 inches square on the top surface, 7 inches in depth, and 4 inches square on the bottom bed. They are of such hardness that without exception they are badly rounded, and extremely slippery, affording an insecure foothold for draft animals. Innumerable falls, resulting in blockades, broken vehicles and harness are the result.

The Boston blocks average 15 inches square on top surface, 10 inches in depth, and 13 inches square on bottom bed. They are of softer stone than the Belgian block, but are badly rounded and afford less foothold to draft animals than Belgian block. Both are laid on an earth foundation with joints filled with sand.

Owing to the lack of storm water sewers a large percentage of this pavement is flooded during rains, when the water soon soaks through the joints and softens the foundation, causing many settlements.

A portion of the Boston block when taken up to be replaced by modern pavement, has been relaid at different localities, for the most part upon Picota and Factoria streets. In such cases the block has been reversed and laid on two inches of thoroughly rammed broken stone, with the joints filled with fine broken stone and grouted with sand cement. To date this has proven quite satisfactory, though it is not possible to obtain a smooth surface by reason of the irregularity of the surface of the blocks.

In the past twelve months the following work has been done on this class of pavement:

| | Linear meters. | Square meters. | Linear miles. |
|-------------------------------------|-------------------|-------------------|------------------|
| Blocks relaid in place..... | 4,902 | 22,793 | 3.045 |
| Blocks relaid in other streets..... | 1,145 | 6,359 | .711 |
| Average force employed | | 84.41 | |

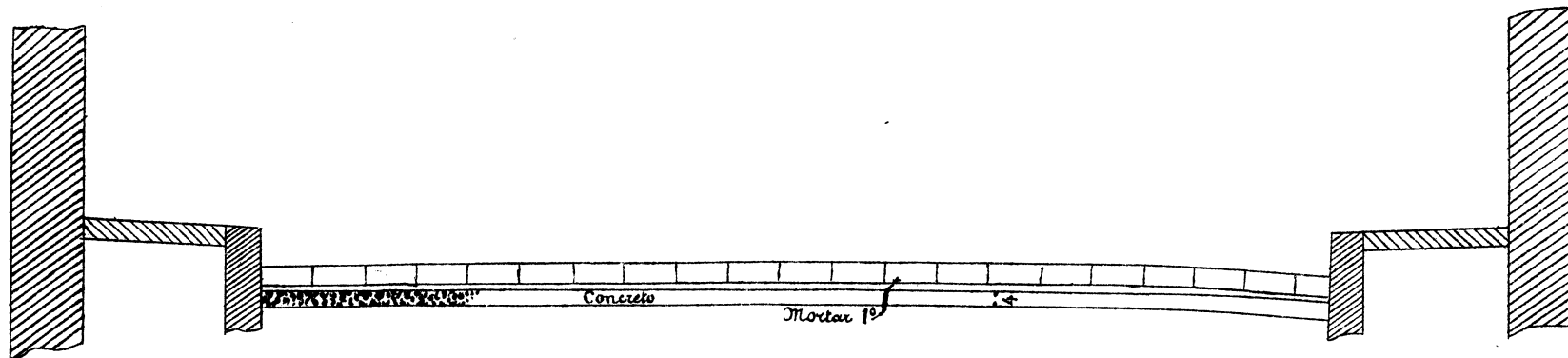
MODERN PAVEMENTS.

TEST PAVEMENTS.

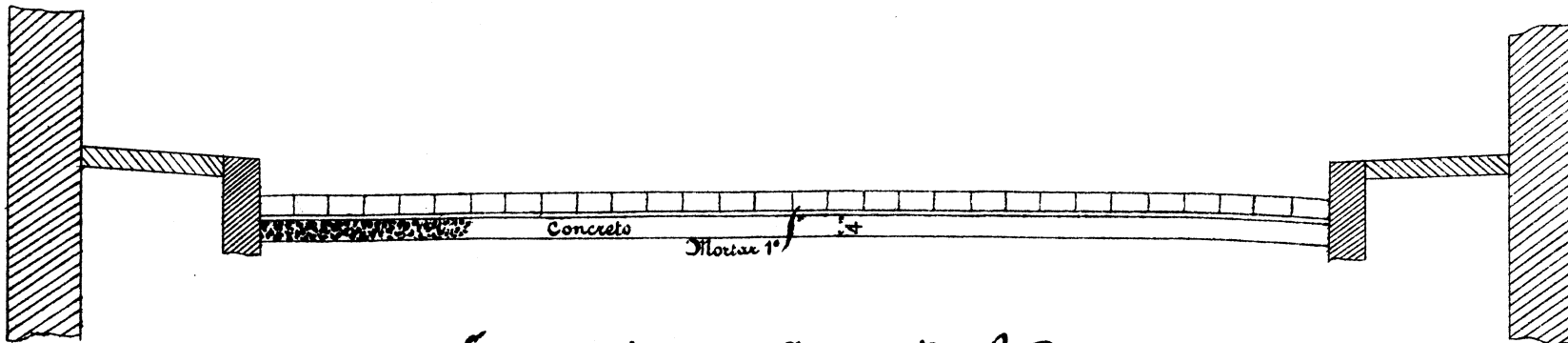
Mention was made in the report for the last fiscal year of the laying of small amounts of asphalt block, sheet asphalt, and vitrified brick pavement, for the purpose of obtaining a comparative test of their values in this climate.

The asphalt block was laid upon concrete foundation, in a cement mortar bed. It has quite successfully undergone the test of twelve months' traffic to which it has been subjected, except on O'Reilly street, at the northeast corner of the military governor's palace (the intersection of that street with Tacon street), where, by reason of the narrow width and a sharp turn, the wheels of vehicles have followed a uniform track of about one-half meter in width. Reference to the tabulated statement of the traffic census will show that 2,500 vehicles pass this point in twelve hours. The pavement has worn quite badly at this place, as shown in the accompanying illustrations. It also shows some wear along the gutters in front of warehouses where heavily loaded carts are standing a considerable portion of the time.

Standard Cross Sections



Standard Cross-Section Asphalt Block Paving
Crown 1/100 of Total Width between Curbs.



Standard Cross-Section Brick Paving.
Crown 1/100 of Total Width between Curbs.

The sheet asphalt pavement in the autumn of 1899 developed a considerable number of small pits, which in some instances increased considerably in size, and in other instances were entirely ironed out by the traffic. These pits may be attributed, in part, to careless laying upon the part of the contractor, and in part to the fact that the small amount of this pavement laid necessitated, as an economic measure, the mixing of the asphalt material in the United States, and its laying by the method of reheating it. This pavement was patched by the contractor during the month of April, to the extent of 633 square meters, equivalent to 5 per cent of the total area. A photograph of this pavement is shown herewith.

The vitrified brick pavement, which was also laid upon a concrete foundation and a sand cushion, together with transverse and longitudinal asphaltic expansion joints, has given fair satisfaction. The large amount of noise resulting from traffic over this pavement, as compared with the asphalt pavement, is a particularly disagreeable feature in the narrow streets of Habana. The make of brick used has given extremely good results in various cities of the United States, but it can not be said to stand well here. A photograph showing the present condition of this pavement is shown in Plate No. 23.

Because of the perennial heat of Habana, it was thought that a comparative idea of the amount of heat absorbed and heat reflected by sheet asphalt, asphalt block, and vitrified brick pavements would be of especial value, and during July, 1899, observations covering a period of ten days were made. Points similarly exposed to sun and shade were selected in each class of pavement and holes just large enough to receive the bulb of a thermometer were bored to a depth of 3 centimeters. Observations were made at 9 a. m., 12 m., 4 p. m., and 9 p. m. Standardized centigrade thermometers were used, and three temperatures were read simultaneously. One thermometer was suspended with its bulb in the pavement, a second was placed 0.3 of a meter above the pavement, and a third was placed 2.4 meters above the pavement and protected from below from all reflected heat. From the readings thus obtained were deduced the temperature of the pavement, of the reflected heat, and of the atmosphere, as shown in graphic form by Plates Nos. 24 and 25.

ASPHALT BLOCK.

The great noisiness of the old Belgian and Boston block pavements existant throughout the old city made necessary, for the proper transaction of business, the laying of pavement of a less noisy character, in the vicinity of several office buildings of the general government. This necessity has resulted in the laying of three blocks of asphalt block pavement in the vicinity of the military governor's palace, four blocks of the same character of pavement around the supreme court building on Cuba and Chacon streets, and approximately three blocks of the same pavement along the front and sides of the custom-house.

The asphalt block on Cuba street was laid on a 6-inch concrete base; vitrified brick gutters 8 feet wide were laid on this street. That on Chacon street was laid on a mortar bed $1\frac{1}{2}$ inches thick, on the old foundation, which consisted of a mixture of sand and clay, compacted so thoroughly that repeated efforts with the drill failed to penetrate more than two or three inches. The asphalt block on Mercaderes and Obispo streets, north of Oficios street, was laid on a foundation pre-

pared by taking up the "Boston" block, taking the subgrade out to the proper form, relaying the old blocks upon a bed 2 inches in depth of small broken stone, filling the block joints with sand, cement, and small broken stone, covering with a 1-inch sand cushion on which were laid the asphalt block with grouted joints, as shown on Plates Nos. 26 and 27. Oficios street, Churruca street, and Teniente Rey in the neighborhood of the custom-house were laid with asphalt block on a 4-inch concrete base, with a 1-inch mortar bed and a vitrified brick gutter 8 inches wide. Oficios street, from Obispo to Justiz street, was laid in the same manner as those adjacent to the custom-house.

The value of this brick gutter to protect the asphalt block from the action of water and the very severe twisting effect of cart wheels when approaching the curb is already apparent. It is believed that under very heavy traffic this gutter should be two bricks wide. The straight joint between the brick and asphalt block is found to be quite satisfactory. Wherever asphalt block has been laid upon a sand cushion the use of a 10-ton steam roller to bring the block to a uniform surface has proven quite satisfactory.

Small amounts of asphalt block pavement were laid on Amargura and Aguiar streets, in the immediate vicinity of their intersection, and on Cuba street between O'Reilly and Empedrado streets. The cost of the block was defrayed by abutting owners. A 4-inch concrete foundation and a 1-inch mortar bed were used.

All concrete for pavement foundation has been mixed in the proportion by volume of 1, 3, 5 for cement, sand, and broken stone, respectively. Calcareous sand only is obtainable in this portion of the island.

In all cases the foundation for modern pavement has been constructed with a view to obtaining an impervious layer beneath the paving material.

Standard sections for asphalt block and vitrified brick pavement accompany this report.

Sand cement grout has been used upon all asphalt block pavement laid, and the result has been quite satisfactory.

The amount and cost of asphalt block pavement laid during the fiscal year follow:

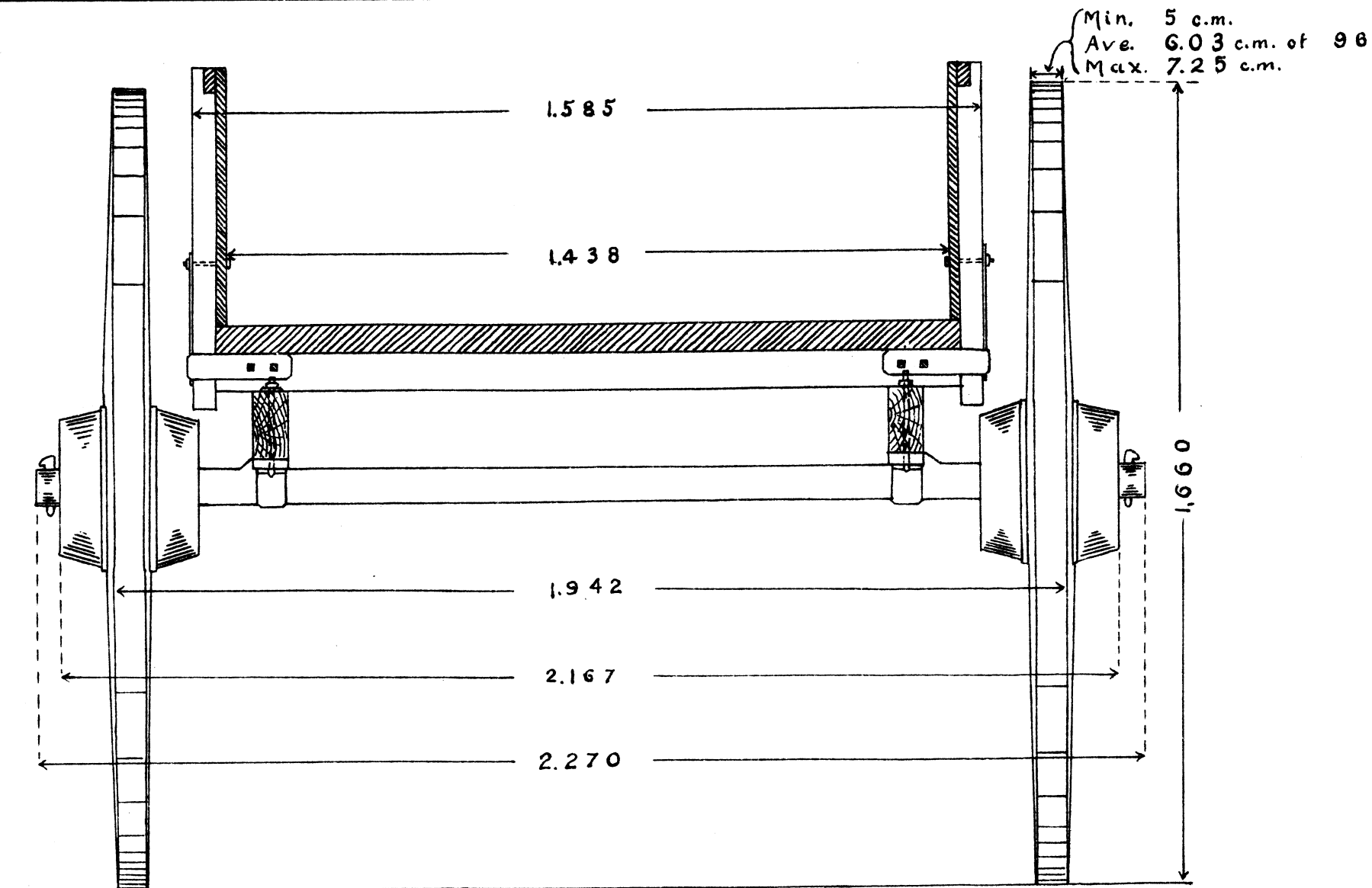
ASPHALT BLOCK PAVING.

| | |
|-------------------------------------|---------|
| Linear meters | 1,028.5 |
| Square meters | 6,135 |
| Linear miles | 0.639 |
| Average cost per square meter | \$5.60 |

VITRIFIED BRICK.

The well-known insufficiency of laboratory tests for determining the wearing qualities of vitrified brick prompted the suggestion by the department to various makers of this paving material that they should deliver to the department, free of cost, at Habana, a sufficient amount of their product to lay 50 square yards of pavement; the brick to be laid by the department, upon concrete foundation, with 1 inch sand cushion. The various brick received have been laid alongside each other, in a continuous piece of pavement, to insure uniformity of traffic.

This was done with the view of considering, at such time as large quantities of this paving material might be needed, bids for only such



Cross - Section
of
Cuban city Cart.

brick as might have successfully undergone the practical test of wear in a pavement.

In response to this suggestion, the following brick were shipped under these conditions and have been laid by the department:

| Brick. | Manufacturer. | Number per square meter of pavement. | When laid. |
|----------------------------------|----------------------------------|--------------------------------------|----------------|
| Macavoy | Macavoy Vitrifed Brick Co | 64.9 | Sept. 25, 1899 |
| E. P. B. | Eastern Paving Brick Co | 67.5 | Sept. 27, 1899 |
| Chilhowie Block | Virginia Paving Brick Co | 60.0 | Sept. 29, 1899 |
| Reynolds Block | Tennessee Paving Brick Co | 55.0 | Dec. 4, 1899 |
| Clearfield Clay Working Co | Clearfield Clay Working Co | 71.7 | Do. |
| Thurber | Green & Hunter Brick Co | 63.0 | Dec. 20, 1899 |
| Pyrogranite | National Pyrogranite Co | 75.1 | Mar. 13, 1900 |

The points chosen for these tests were Caballeria wharf, with a special view to obtaining the twisting effect of the carts in moving to and away from the wharf, and the Calzada del Cerro, which is the principal avenue to the rural districts.

Attention is invited to the accompanying plates, showing the present condition of these small portions of pavement.

The very high cost and extreme noisiness of Belgian block pavement render it so objectionable for the narrow streets of the business portion of Habana that vitrified-brick pavement was laid upon Oficios street, for a length of two blocks, and across the Plaza de San Francisco (where the extremely heavy warehouse traffic is highly concentrated), with a view to determining the sufficiency of this material for that character of traffic, this pavement being laid upon a 4-inch concrete foundation, with a 1-inch sand cushion. For about half, the joints are grouted with sand cement. This portion is also provided with transverse and longitudinal asphaltic expansion joints. For the remainder the joints are filled with sand and No. 6 paving pitch. The amount of vitrified-brick paving laid during the year is:

| | |
|-------------------------------------|--------|
| Linear meters | 420.89 |
| Square meters | 2,527 |
| Linear miles | .262 |
| Average cost per square meter | \$4.22 |

For data as to the minimum thickness of concrete foundation which might be employed on firm earth, a small amount of brick pavement was laid early in the fiscal year, on the Calzada del Cerro, upon a 2½-inch foundation. Nine months' wear has demonstrated that this thickness is not sufficient under the conditions there existing—a concentration of heavy cart traffic upon the narrow space (about 2.5 meters) between the tramway track and the sidewalk. Four inches of concrete has in every instance withstood the traffic, but it has only been laid upon a firm subsoil.

TRAFFIC.

The character, extent, and severity of the traffic which follows certain lines of travel in Habana are difficult of comprehension to anyone not familiar therewith from actual observation. To convey some idea as to its volume and severity, a count has been made of the number and character of vehicles passing various points in the city between the hours of 6 a. m. and 6 p. m. The results of this count are given

in plates Nos. 38 and 39. The four-wheel wagons, two mules, and four-wheel wagons, four mules, referred to in plates Nos. 38 and 39, are practically all omnibuses. A cross section of a one-mule cart, similar to those in which 90 per cent of the hauling of the city is done is shown in plate No. 37. The width of tire of 96 of these carts was measured. The mean of these measurements was 6.03 centimeters—about $2\frac{1}{2}$ inches. The average weight was 1,950 pounds; the average load hauled, 4,000 pounds.

The concentration of traffic upon certain portions of the various streets in the warehouse district of the city has been highly accentuated by the necessity of unloading carts at the front entrances to warehouses. Such standing of carts occupies in general about half the width of the street, forcing all passing vehicles to the remaining portion. An example of the severity of such concentration is shown in the photograph (plate No. 40) of a portion of the asphalt-block pavement laid with brick gutter in front of the custom-house. It was not believed at the time this pavement was laid that its character was such as to withstand the amount of traffic in that vicinity, but the immense volume of business conducted at the custom-house necessitated a practically noiseless pavement.

Plates embodying the results of this traffic census also show the street widths between curbs, data of high importance in the consideration of the wear to which Habana pavements are daily subjected. Oficinas street, in front of the custom-house, had an average of 91 one-mule carts per hour. The width of street at the point where the count was made is only 4.7 meters (15 feet 8 inches).

For many years Habana has had an ordinance prescribing widths for tires, in which the minimum width was 10 centimeters (4 inches), and the maximum width 15 centimeters (6 inches). Examination of the traffic census will show that no attention has been given to enforcing this old ordinance. In April of the present calendar year a new tire ordinance, prescribing not only the width of tire but size of axle, was, in conformity with recommendations of the department, enacted by the city council. This ordinance became operative for new vehicles from April 15, and will apply to all vehicles after June 30, 1901. The widths prescribed for tires are shown in the following table:

Traffic census, Habana, Cuba.

| Street. | Width of street. | Class of pavement. | Width {Min of Ave. Max.} | Cm. | Carts, 1 mule. | | Carts, 2 mules. | | Carts, 3 mules. | | Carts, 4 mules. | | Carts, 5 mules. | | 4 wheels, 2 animals. | | Centimeters. | | Total point in 12 hours. |
|--------------------------------------------------------|------------------|--------------------|--------------------------|-------|----------------|---------|-----------------|---------|-----------------|---------|-----------------|---------|-----------------|---------|----------------------|---------|--------------|---------|--------------------------|
| | | | | | Empty. | Loaded. | Empty. | Loaded. | Empty. | Loaded. | Empty. | Loaded. | Empty. | Loaded. | Empty. | Loaded. | Empty. | Loaded. | |
| Dragones, between Prado and Villanueva. | Meters. 9.0 | | Minimum | 24.0 | 25.0 | 17.0 | 1.50 | 2.00 | 0.08 | 1.33 | 0.08 | 1.00 | 0.17 | 1.00 | 2.33 | 39.00 | 27.00 | 1.25 | 3,402 |
| | | | Average | 164.0 | 40.0 | 30.0 | 5.00 | 4.00 | 1.00 | 5.00 | 1.00 | 4.00 | 2.00 | 8.00 | 5.00 | 64.00 | 8.00 | 4.25 | |
| | | | Maximum | 290.0 | 62.0 | 48.0 | 5.00 | 4.00 | 1.00 | 5.00 | 1.00 | 4.00 | 2.00 | 8.00 | 5.00 | 64.00 | 8.00 | 5.00 | |
| | | | Minimum | 24.0 | 21.0 | 13.0 | 2.06 | 2.33 | 0.17 | 0.40 | 0.08 | 0.33 | 0.17 | 1.00 | 10.00 | 3.00 | 0.25 | 0.33 | 2,502 |
| | | | Average | 113.0 | 38.0 | 39.0 | 5.00 | 4.00 | 1.00 | 1.00 | 1.00 | 2.00 | 2.00 | 20.00 | 6.00 | 1.00 | 1.00 | 2.00 | |
| O'Reilly, at northeast corner palace. | 5.95 | | Maximum | 180.0 | 47.0 | 73.0 | 5.00 | 4.00 | 1.00 | 1.00 | 1.00 | 2.00 | 2.00 | 20.00 | 6.00 | 1.00 | 1.00 | 0.83 | 711 |
| | | | Minimum | 8.0 | 1.0 | 1.0 | 0.33 | 4.00 | 0.08 | 8.00 | 0.08 | 1.00 | 0.08 | 1.00 | 11.00 | 7.00 | 2.00 | 0.83 | |
| | | | Average | 19.0 | 7.0 | 10.0 | 2.00 | 8.00 | 0.08 | 8.00 | 0.08 | 1.00 | 0.08 | 1.00 | 20.00 | 12.00 | 2.00 | 0.83 | |
| | | | Maximum | 39.0 | 17.0 | 19.0 | 2.00 | 8.00 | 0.08 | 8.00 | 0.08 | 1.00 | 0.08 | 1.00 | 20.00 | 12.00 | 2.00 | 0.83 | |
| | | | Average | 39.0 | 17.0 | 19.0 | 2.00 | 8.00 | 0.08 | 8.00 | 0.08 | 1.00 | 0.08 | 1.00 | 20.00 | 12.00 | 2.00 | 0.83 | |
| Vedado road, near street-railway crossing. | 10.0 | | Minimum | 39.0 | 17.0 | 19.0 | 2.00 | 8.00 | 0.08 | 8.00 | 0.08 | 1.00 | 0.08 | 1.00 | 20.00 | 12.00 | 2.00 | 0.83 | |
| | | | Average | 43.0 | 60.0 | 31.0 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 2.00 | 0.17 | 2.30 | 1,708 |
| | | | Maximum | 78.0 | 115.0 | 52.0 | 1.00 | 2.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 2.00 | 6.00 | 1.00 | 11.00 | |
| | | | Minimum | 21.0 | 12.0 | 4.0 | 1.00 | 2.25 | 0.17 | 0.17 | 0.08 | 0.17 | 0.08 | 0.17 | 1.00 | 5.00 | 0.08 | 0.75 | 1,639 |
| | | | Average | 76.0 | 22.0 | 20.0 | 4.00 | 5.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 18.00 | 15.00 | 0.08 | 0.75 | |
| Belascoain, between San Miguel and Neptuno. | 11.5 | | Maximum | 135.0 | 40.0 | 20.0 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 5.00 | 20.00 | 1.00 | 3.00 | 1,752 |
| | | | Minimum | 33.0 | 17.0 | 5.0 | 1.00 | 1.00 | 0.67 | 3.00 | 0.17 | 0.83 | 0.08 | 0.33 | 20.00 | 20.00 | 3.00 | 4.00 | |
| | | | Average | 23.0 | 28.0 | 17.0 | 4.00 | 10.00 | 3.00 | 6.00 | 1.00 | 3.00 | 1.00 | 2.00 | 47.00 | 40.00 | 8.00 | 9.00 | |
| | | | Maximum | 73.0 | 63.0 | 32.0 | 8.00 | 23.00 | 3.00 | 6.00 | 1.00 | 3.00 | 1.00 | 2.00 | 47.00 | 40.00 | 8.00 | 9.00 | |
| | | | Average | 73.0 | 63.0 | 32.0 | 8.00 | 23.00 | 3.00 | 6.00 | 1.00 | 3.00 | 1.00 | 2.00 | 47.00 | 40.00 | 8.00 | 9.00 | |
| Calzada del Cerro, between Infanta and Cruz del Padre. | 9.5 | | Minimum | 7.0 | 10.0 | 4.0 | 2.00 | 8.00 | 0.17 | 0.34 | 0.08 | 0.17 | 0.08 | 0.08 | 0.83 | 3.00 | 0.08 | 0.33 | 811 |
| | | | Average | 11.0 | 21.0 | 20.0 | 6.00 | 17.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 4.00 | 7.00 | 1.00 | 1.00 | |
| | | | Maximum | 16.0 | 32.0 | 30.0 | 6.00 | 17.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 4.00 | 7.00 | 1.00 | 1.00 | |
| | | | Minimum | 30.0 | 10.0 | 3.0 | 1.25 | 1.00 | 0.33 | 1.16 | 0.33 | 1.16 | 0.33 | 0.33 | 4.50 | 1.50 | 36.00 | 12.00 | |
| | | | Average | 71.0 | 25.0 | 9.0 | 3.60 | 3.60 | 1.00 | 0.33 | 1.16 | 0.33 | 1.08 | 0.33 | 4.50 | 1.50 | 36.00 | 12.00 | |
| Vives, between Figuras and Car-men. | 12.5 | | Maximum | 97.0 | 57.0 | 18.0 | 1.00 | 3.00 | 2.00 | 2.00 | 1.00 | 1.00 | 3.00 | 1.00 | 9.00 | 4.00 | 45.00 | 15.00 | 2,091 |
| | | | Minimum | 18.0 | 9.0 | 10.0 | 1.66 | 3.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 7.00 | 8.00 | 1.85 | 0.75 | |
| | | | Average | 64.0 | 29.0 | 27.0 | 1.66 | 3.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 7.00 | 8.00 | 1.85 | 0.75 | |
| | | | Maximum | 155.0 | 61.0 | 65.0 | 3.00 | 8.00 | 2.00 | 2.00 | 1.00 | 1.00 | 2.58 | 14.70 | 15.00 | 22.00 | 3.00 | 3.00 | 1,977 |
| | | | Average | 155.0 | 61.0 | 65.0 | 3.00 | 8.00 | 2.00 | 2.00 | 1.00 | 1.00 | 2.58 | 14.70 | 15.00 | 22.00 | 3.00 | 3.00 | |
| Príncipe Alfonso, between Rastro and Cuatro Caminos. | 10.5 | | Minimum | 15.0 | 9.0 | 2.0 | 0.33 | 0.16 | 0.17 | 0.08 | 0.16 | 0.16 | 0.08 | 0.16 | 3.33 | 1.61 | 0.08 | 0.08 | 1,548 |
| | | | Average | 77.0 | 27.5 | 18.0 | 0.33 | 0.16 | 0.17 | 0.08 | 0.16 | 0.16 | 0.08 | 0.16 | 3.33 | 1.61 | 0.08 | 0.08 | |
| | | | Maximum | 105.0 | 40.0 | 28.0 | 2.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| | | | Minimum | 26.0 | 19.0 | 15.0 | 2.58 | 8.00 | 0.58 | 2.66 | 0.08 | 1.33 | 0.75 | 2.25 | 84.50 | 8.00 | 10.00 | 8.00 | |
| | | | Average | 63.7 | 32.7 | 23.0 | 2.58 | 8.00 | 0.58 | 2.66 | 0.08 | 1.33 | 0.75 | 2.25 | 84.50 | 8.00 | 10.00 | 8.00 | 2,381 |
| Carlos III, between Soledad and Oquendo. | 16.0 | | Maximum | 98.0 | 39.0 | 41.0 | 8.00 | 13.00 | 1.00 | 8.00 | 1.00 | 3.00 | 4.00 | 7.00 | 7.00 | 76.00 | 13.00 | 13.00 | |
| | | | Minimum | 98.0 | 39.0 | 41.0 | 8.00 | 13.00 | 1.00 | 8.00 | 1.00 | 3.00 | 4.00 | 7.00 | 7.00 | 76.00 | 13.00 | 13.00 | |
| | | | Average | 98.0 | 39.0 | 41.0 | 8.00 | 13.00 | 1.00 | 8.00 | 1.00 | 3.00 | 4.00 | 7.00 | 7.00 | 76.00 | 13.00 | 13.00 | |
| | | | Maximum | 98.0 | 39.0 | 41.0 | 8.00 | 13.00 | 1.00 | 8.00 | 1.00 | 3.00 | 4.00 | 7.00 | 7.00 | 76.00 | 13.00 | 13.00 | |
| | | | Average | 98.0 | 39.0 | 41.0 | 8.00 | 13.00 | 1.00 | 8.00 | 1.00 | 3.00 | 4.00 | 7.00 | 7.00 | 76.00 | 13.00 | 13.00 | |
| Mercederes, between Obispo and Obrapia. | 4.92 | | Minimum | 77.0 | 27.5 | 18.0 | 0.33 | 0.16 | 0.17 | 0.08 | 0.16 | 0.16 | 0.08 | 0.16 | 3.33 | 1.61 | 0.08 | 0.08 | 1,548 |
| | | | Average | 77.0 | 27.5 | 18.0 | 0.33 | 0.16 | 0.17 | 0.08 | 0.16 | 0.16 | 0.08 | 0.16 | 3.33 | 1.61 | 0.08 | 0.08 | |
| | | | Maximum | 105.0 | 40.0 | 28.0 | 2.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| | | | Minimum | 26.0 | 19.0 | 15.0 | 2.58 | 8.00 | 0.58 | 2.66 | 0.08 | 1.33 | 0.75 | 2.25 | 84.50 | 8.00 | 10.00 | 8.00 | |
| | | | Average | 63.7 | 32.7 | 23.0 | 2.58 | 8.00 | 0.58 | 2.66 | 0.08 | 1.33 | 0.75 | 2.25 | 84.50 | 8.00 | 10.00 | 8.00 | |
| Puente de Chaves | 10.5 | | Maximum | 98.0 | 39.0 | 41.0 | 8.00 | 13.00 | 1.00 | 8.00 | 1.00 | 3.00 | 4.00 | 7.00 | 7.00 | 76.00 | 13.00 | 13.00 | |
| | | | Minimum | 98.0 | 39.0 | 41.0 | 8.00 | 13.00 | 1.00 | 8.00 | 1.00 | 3.00 | 4.00 | 7.00 | 7.00 | 76.00 | 13.00 | 13.00 | |
| | | | Average | 98.0 | 39.0 | 41.0 | 8.00 | 13.00 | 1.00 | 8.00 | 1.00 | 3.00 | 4.00 | 7.00 | 7.00 | 76.00 | 13.00 | 13.00 | |
| | | | Maximum | 98.0 | 39.0 | 41.0 | 8.00 | 13.00 | 1.00 | 8.00 | 1.00 | 3.00 | 4.00 | 7.00 | 7.00 | 76.00 | 13.00 | 13.00 | |
| | | | Average | 98.0 | 39.0 | 41.0 | 8.00 | 13.00 | 1.00 | 8.00 | 1.00 | 3.00 | 4.00 | 7.00 | 7.00 | 76.00 | 13.00 | 13.00 | |

| | | | | | | | | | | | | | | | | |
|--------------------------------------------------|------|---------------|---------|-------|------|------|------|------|------|------|-------|------|-------|-------|-------|------|
| Amargura, between Mercaderes and Oficinas. | 5.0 | Boston block | Minimum | 49.5 | 3.0 | 1.00 | 1.00 | 0.30 | 0.50 | 0.20 | 0.25 | 1.00 | 5.00 | 1,570 | | |
| | | | Average | 74.0 | 44.0 | 1.25 | 1.80 | 0.30 | 0.20 | 0.30 | 0.20 | 0.25 | 1.00 | | 5.00 | |
| | | | Maximum | 75.0 | 75.0 | 3.00 | 4.00 | 2.00 | 4.00 | 1.00 | 1.00 | 1.00 | 7.00 | | 10.00 | |
| Belascoain, between Tenerife and Cuatro Caminos. | 11.6 | Macadam | Minimum | 25.0 | 19.0 | 1.00 | 3.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 6.00 | 1,934 | | |
| | | | Average | 50.7 | 32.0 | 29.6 | 2.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.60 | | 0.10 | 0.80 |
| | | | Maximum | 51.0 | 48.0 | 20.0 | 2.00 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 1.00 | | 1.00 | 2.00 |
| Galiano, between Dragones and Reina. | 12.0 | Belgian block | Minimum | 28.0 | 9.0 | 4.0 | 1.00 | 1.00 | 1.00 | 4.00 | 38.00 | 1.00 | 1.80 | 2,430 | | |
| | | | Average | 50.7 | 33.8 | 8.0 | 0.25 | 1.00 | 0.10 | 0.10 | 0.10 | 0.30 | 23.40 | | 0.80 | 1.00 |
| | | | Maximum | 132.0 | 27.0 | 12.0 | 2.00 | 4.00 | 1.00 | 1.00 | 1.00 | 4.00 | 39.00 | | 3.00 | 6.00 |

| 2-wheel cart, without springs, to carry 1,000 kilograms. | | 4-wheel wagon without springs. | | | |
|----------------------------------------------------------|---------------------|--------------------------------|-------------------------|---------------------|---------------------|
| Weight of cart. | Width of tire. | Weight of wagon. | Width of tire to carry— | | |
| | | | 1,000 kilograms. | 1,500 kilograms. | 2,000 kilograms. |
| <i>Kilograms.</i> | <i>Millimeters.</i> | <i>Kilograms.</i> | <i>Millimeters.</i> | <i>Millimeters.</i> | <i>Millimeters.</i> |
| 300 | 66 | 300 | 50 | 50 | 58 |
| 350 | 69 | 350 | 50 | 50 | 60 |
| 400 | 71 | 400 | 50 | 50 | 61 |
| 450 | 74 | 450 | 50 | 50 | 62 |
| 500 | 76 | 500 | 50 | 51 | 64 |
| 550 | 79 | 550 | 50 | 52 | 65 |
| 600 | 81 | 600 | 50 | 53 | 66 |
| 650 | 84 | 650 | 50 | 55 | 67 |
| 700 | 86 | 700 | 50 | 56 | 69 |
| 750 | 89 | 750 | 50 | 57 | 70 |
| 800 | 91 | 800 | 50 | 58 | 71 |
| 850 | 94 | 850 | 50 | 60 | 72 |
| 900 | 97 | 900 | 50 | 61 | 74 |
| 950 | 99 | 950 | 50 | 62 | 75 |
| 1,000 | 102 | 1,000 | 51 | 64 | 76 |
| 1,050 | 104 | 1,050 | 52 | 65 | 77 |
| 1,100 | 107 | 1,100 | 53 | 66 | 79 |
| 1,150 | 109 | 1,150 | 55 | 67 | 80 |
| 1,200 | 112 | 1,200 | 56 | 69 | 81 |

Traffic in certain sections, which were at the beginning of the year badly congested, has, in a measure, been diffused by reason of the increase in the number of streets in a fair condition. This is particularly noticeable on the Calzada del Monte. A very large proportion of the traffic which formerly used this avenue has been transferred to Corrales and Gloria streets, narrow roadways, both of which were thoroughly macadamized early in the fiscal year. The cost per square meter of macadamizing Corrales street was 51 cents (total, \$3,193). The macadamizing was completed in September, since which time 23 cents per square meter (a total of \$1,539) has been expended upon its maintenance.

Plate No. 41 shows the type of cart used in hauling produce from the country to the city, or merchandise from the city to the country. The average width of tire of these carts is 7.4 centimeters (3 inches); average weight, 4,000 pounds; average load, 6,000 to 8,000 pounds. These vehicles are drawn by from 3 to 6 mules, driven tandem.

SIDEWALKS AND CURBING.

No new work of this character has been done during the year, but a considerable amount of labor has been expended in repairing existing sidewalks and curbing. The amount of this work is as follows:

| | |
|----------------------------------------|-------|
| Flagging repaired, square meters | 7,356 |
| Curbing reset, lineal meters | 3,807 |
| Average force employed | 10 |

BRIDGES AND CULVERTS.

A small number of old wooden culverts of short span have been replaced by brick arches. In general, repairs to bridges and culverts have been limited to such work as was absolutely necessary to the maintenance of traffic.

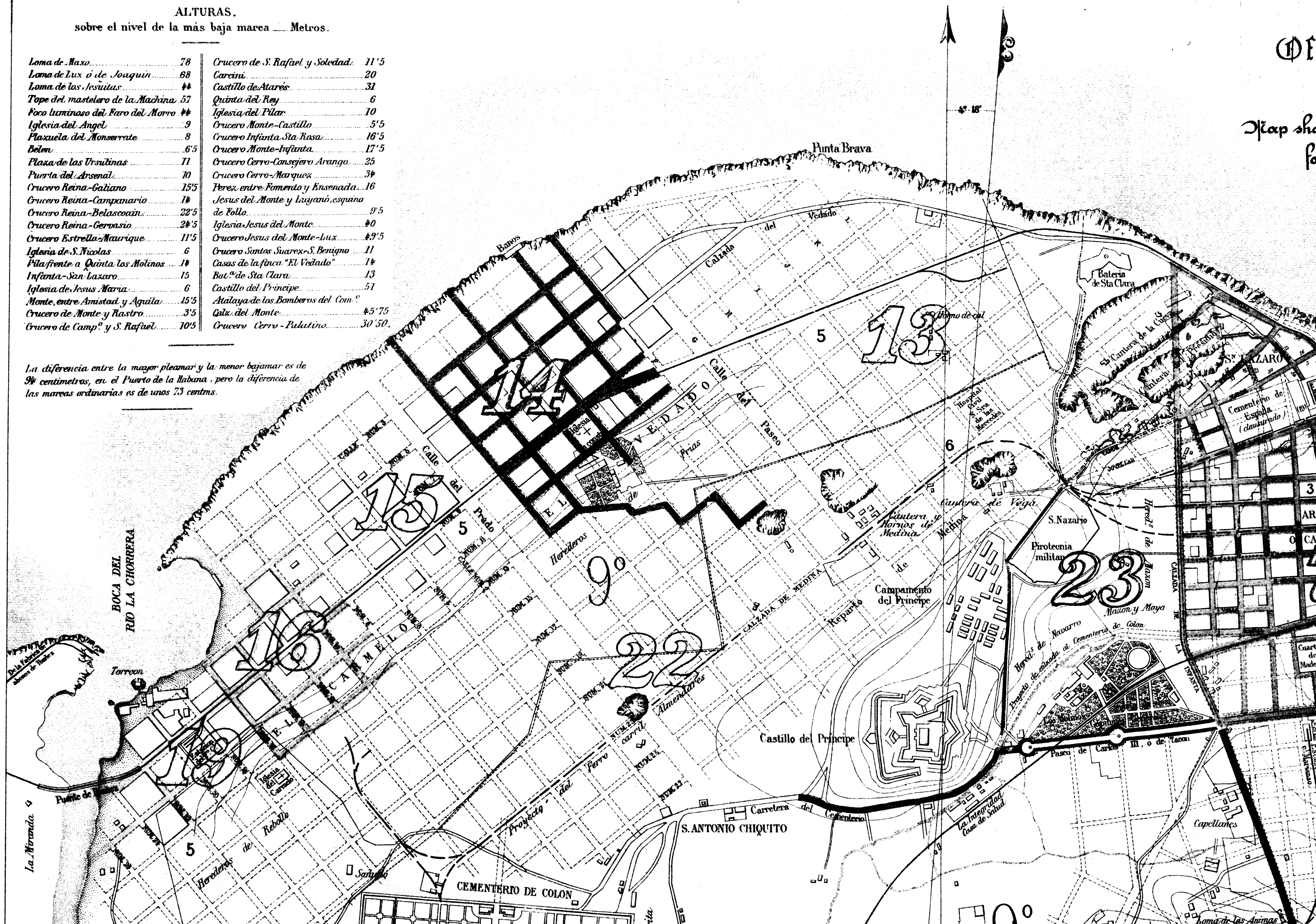
A fence has been built on each side of the Infanta extension, but the major portion of the work done under this head has been expended in the maintenance of the wooden covers of the ditch sewers on the Calzadas del Cerro, Jesus del Monte, and Luyano.

An average force of 16.46 men has been employed on this work.

sobre el nivel de la más baja marea ____ Metros.

| | | | |
|-------------------------------------------|------|-----------------------------------------------|-------|
| Loma de Maxo | 78 | Crucero de S. Rafael y Soledad | 11'5 |
| Loma de Lux o de Jouquin | 68 | Carcini | 20 |
| Loma de las Jesuitas | 44 | Castillo de Atarés | 31 |
| Tope del mastelero de la Machina | 57 | Quinta del Rey | 6 |
| Foco luminoso del Faro del Morro | 44 | Iglesia del Pilar | 10 |
| Iglesia del Angel | 9 | Crucero Monte-Castillo | 5'5 |
| Plaxuela del Monserrate | 8 | Crucero Infanta Sta Rosa | 16'5 |
| Belen | 6'5 | Crucero Monte-Infanta | 17'5 |
| Plaza de las Ursulinas | 11 | Crucero Cerro-Consajero Arango | 25 |
| Puerta del Arsenal | 10 | Crucero Cerro-Marquez | 34 |
| Crucero Reina-Galiano | 15'5 | Perez, entre Fomero y Ensenada | 16 |
| Crucero Reina-Campesano | 14 | Jesus del Monte y Luján, esquina | |
| Crucero Reina-Belascosain | 22'5 | de Follo | 9'5 |
| Crucero Reina-Cervasio | 22'5 | Iglesia Jesus del Monte | 40 |
| Crucero Estrella-Maurique | 11'5 | Crucero Jesus del Monte-Lux | 49'5 |
| Iglesia de S. Nicolas | 6 | Crucero Santos Suarez-S. Benigno | 11 |
| Pila frente a Quinta los Molinos | 14 | Casas de la finca "El Vedado" | 14 |
| Infanta-San Lázaro | 15 | Bat. ^a de Sta Clara | 13 |
| Iglesia de Jesus Maria | 6 | Castillo del Principe | 51 |
| Monte, entre Amistad y Aguila | 15'5 | Atalaya de los Bomberos del Com. ^o | |
| Crucero de Monte y Rastro | 3'5 | Calk del Monte | 45'75 |
| Crucero de Camp. ^o y S. Rafael | 10'5 | Crucero Cerro-Palutino | 30'50 |

La diferencia entre la mayor pleamar y la menor bajamar es de 94 centímetros, en el Puerto de la Habana, pero la diferencia de las mareas ordinarias es de unos 73 cms.

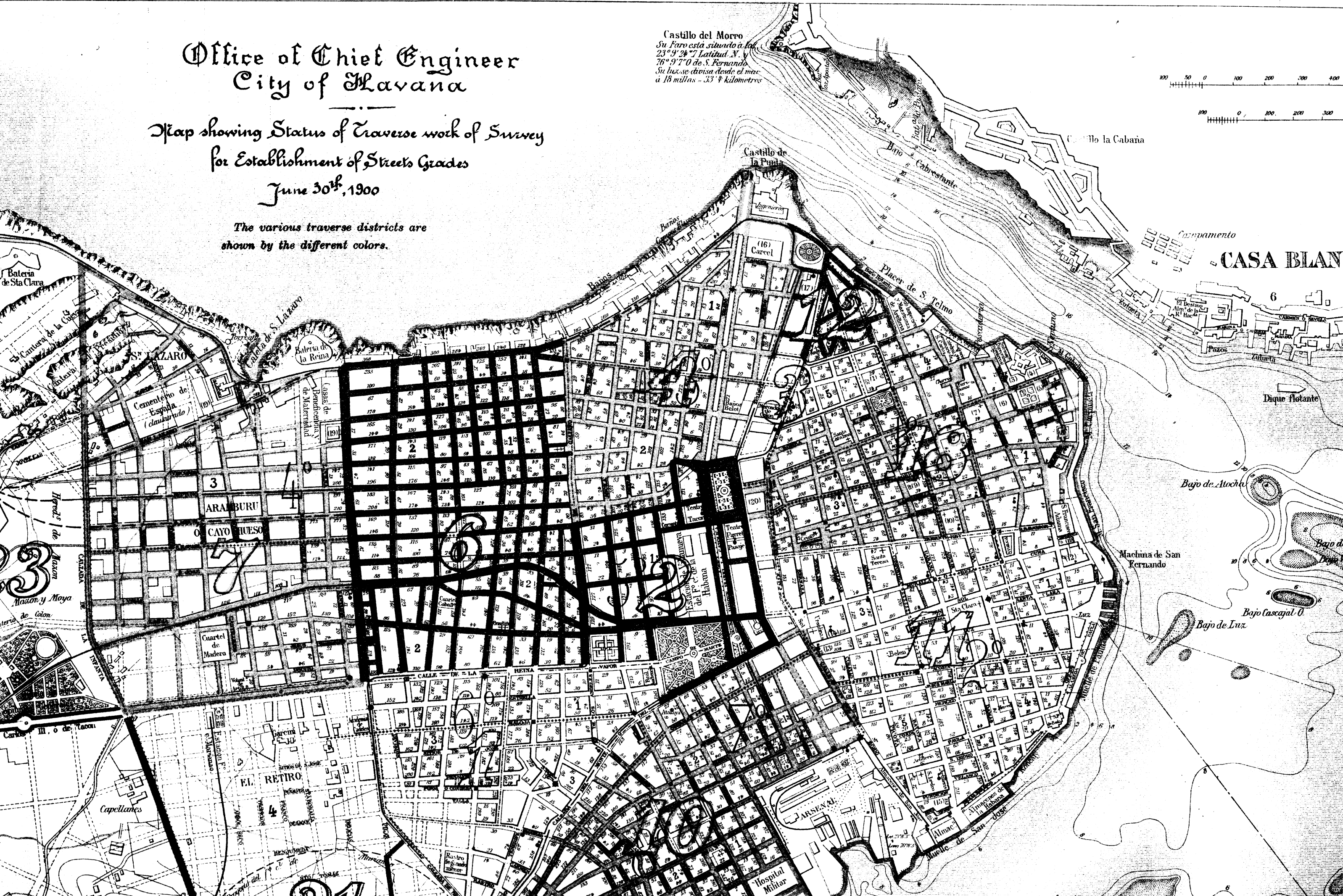
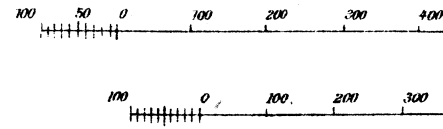


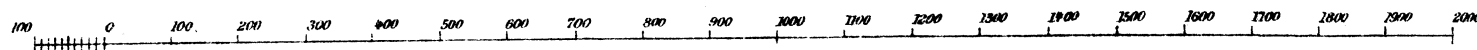
Office of Chief Engineer City of Havana

Map showing Status of Traverse work of Survey
for Establishment of Streets Grades
June 30th, 1900

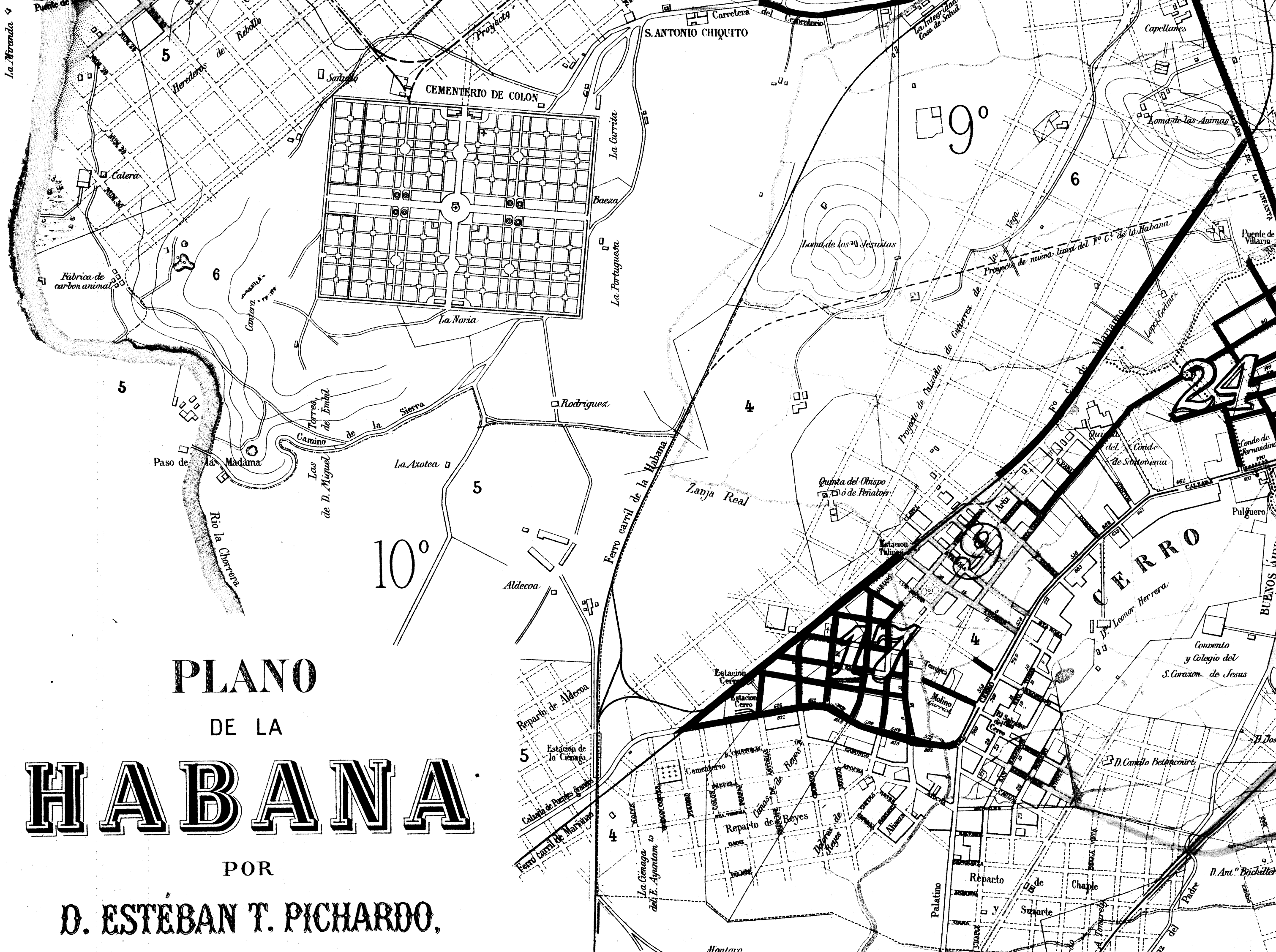
The various traverse districts are
shown by the different colors.

Castillo del Morro
Su Faro está situado a las
23° 9' 24" Latitud N. y
76° 9' 7" O de S. Fernando
Su luz se divisa desde el mar
a 16 millas - 33 1/2 kilometros



[illegible]

Varas cubanas
Escala 10.000¹



PLANO DE LA HABANA

POR
D. ESTEBAN T. PICHARDO,



PLANO DE LA HABANA

POR
D. ESTEBAN T. PICHARDO,

AGRIMENSOR Y MAESTRO DE OBRAS.

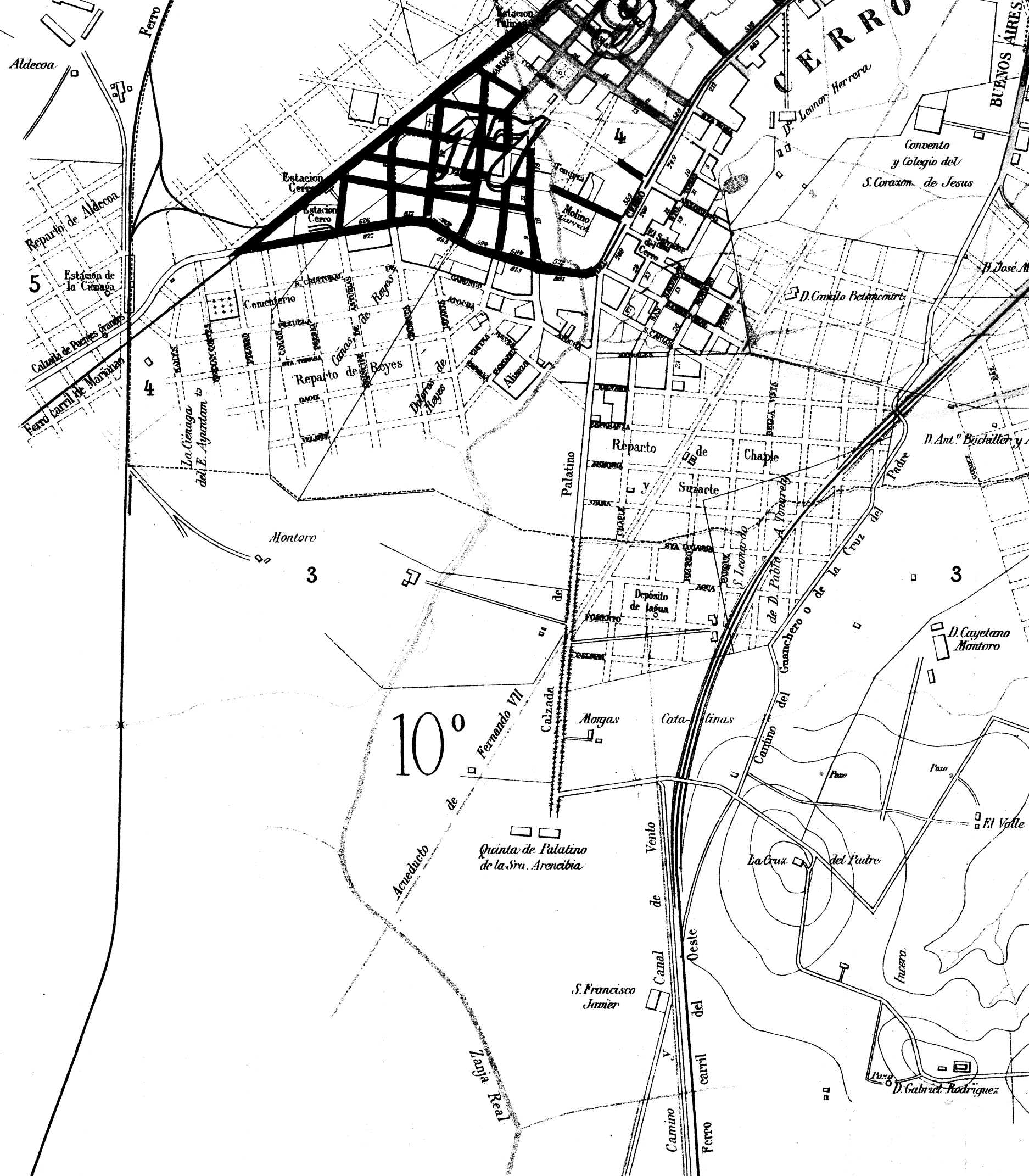
EDITOR: D. JOSÉ VALDEPARES.

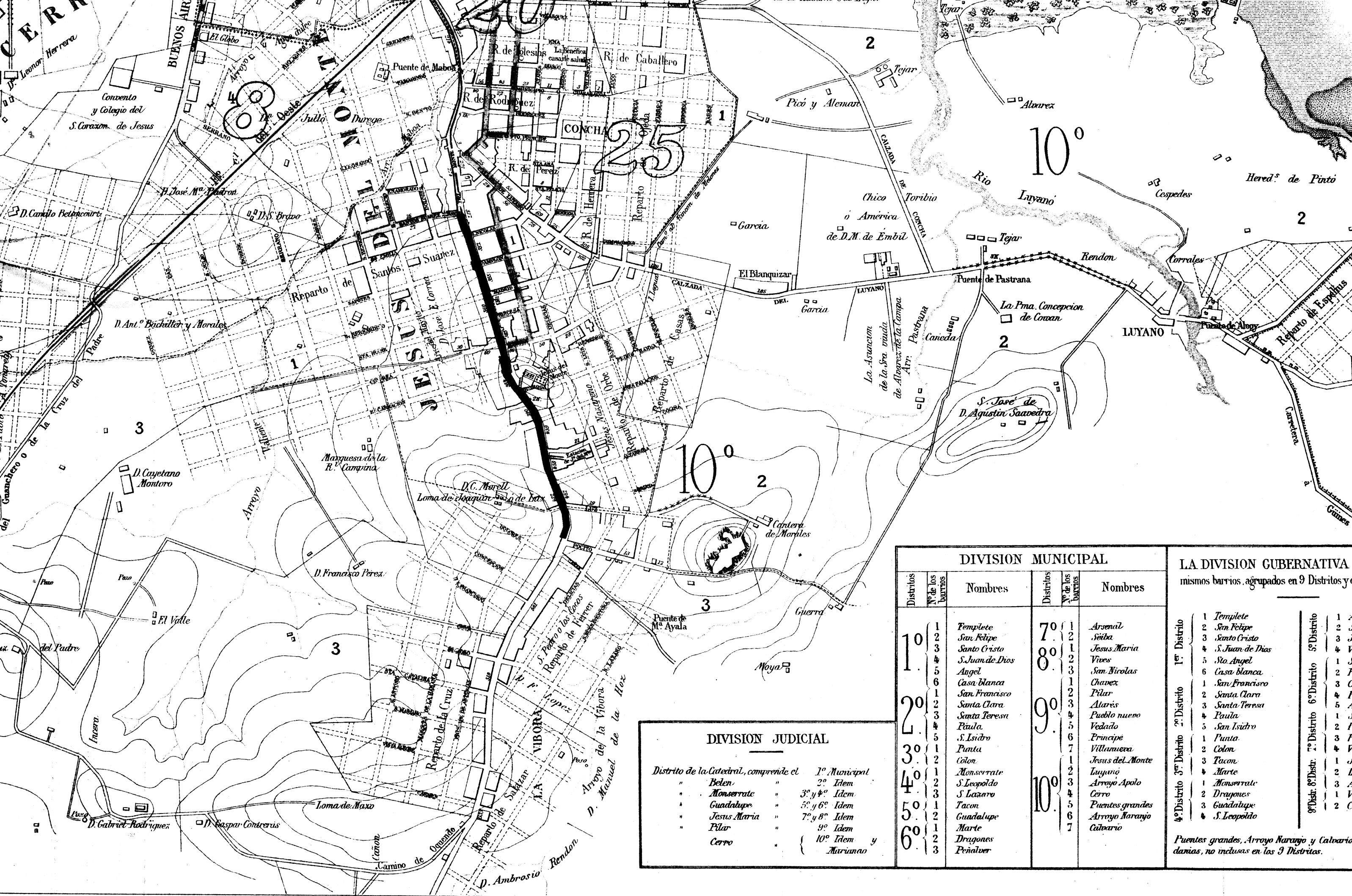
Para la formación de este Plano, se han tenido presentes el publicado por el Excmo. Ayuntamiento, el del Puerto por los Ingenieros de Obras publicas y otros debidos a los Sres. D. Mariano Carles, D. José Ocampo, D. J. Manuel Alvaro, D. Alberto de Castro, D. Antonio Ariza, D. José Lopez Trigo, D. José C. del Castillo, D. Simon Teja & ; cuyos trabajos ha combinado el Autor del presente, añadiendo los que practico expofeso sobre el terreno.

Las curvas de igual sonda, dibujadas en el Puerto, indican la profundidad del agua de dos en dos metros, en baja mar, y están deducidas del sondeo verificado por O. públicas en 1874.

- | | | |
|-----------|---------------------------------|-------------------------|
| ⚡ | Estac. ^a telegráfica | Servicio de Bomberos |
| ■ | Caja de agua | |
| ◆ | Caja y sifón | |
| ● | Sifón | |
| — | Ferrocarril en explotación | |
| - - - | Idem en proyecto | |
| † | Parroquia | |
| - · - · - | Límite Municipal | |
| - · - · - | Idem de Distrito municipal | |
| - · - · - | Idem de Barrio | |
| ++++ | Idem de Parroquia | |

Los números de las casas corresponden al último de cada frente de manzana y están escritos en carácter italico, como 1, 2, 3, 4. Los que se refieren a la numeración del Directorio, están escritos en carácter romano, y entre paréntesis: (1) (2) (3) (4). Los ordinales de los Distritos municipales son de carácter capitales y llaman grande: 1^o. Los de los barrios son de carácter romano, mayores que los del Directorio: 1, 2, 3.



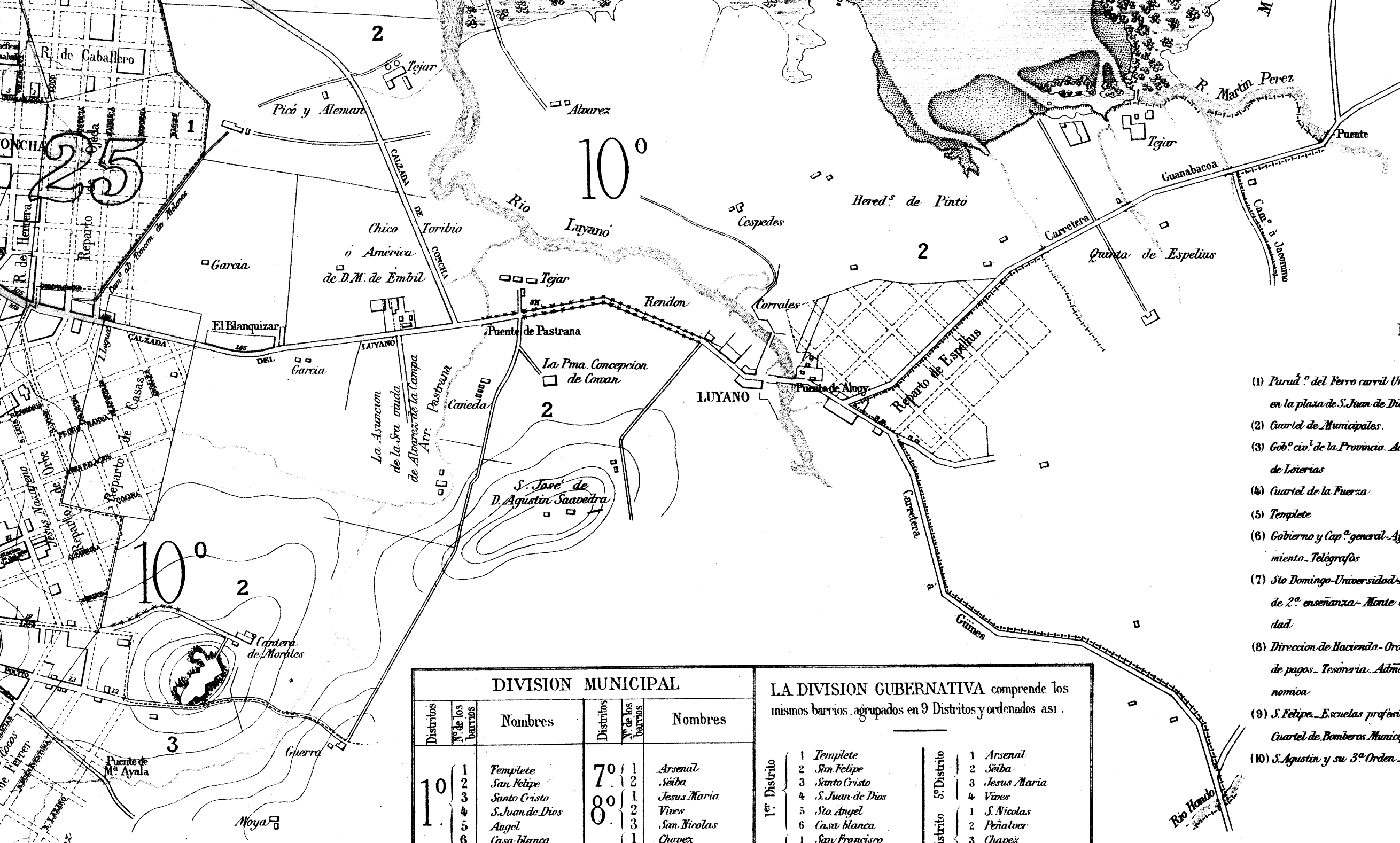


| DIVISION JUDICIAL | | | |
|---------------------------------------|-------------|-----------------------|--|
| Distrito de la Catedral, comprende el | | 1º Municipal | |
| " | Belen | 2º Idem | |
| " | Montserrat | 3º y 4º Idem | |
| " | Guadalupe | 5º y 6º Idem | |
| " | Jesus Maria | 7º y 8º Idem | |
| " | Pilar | 9º Idem | |
| " | Cerro | 10º Idem y Miraflores | |

| DIVISION MUNICIPAL | | | |
|--------------------|-------------------|-----------------|--|
| Distritos | Nº de los barrios | Nombres | |
| 1º | 1 | Templete | |
| | 2 | San Felipe | |
| | 3 | Santo Cristo | |
| | 4 | S. Juan de Dios | |
| | 5 | Angel | |
| | 6 | Casa blanca | |
| 2º | 1 | San Francisco | |
| | 2 | Santa Clara | |
| | 3 | Santa Teresa | |
| | 4 | Paula | |
| | 5 | S. Isidro | |
| 3º | 1 | Punta | |
| | 2 | Colon | |
| | 3 | Montserrat | |
| 4º | 1 | S. Leopoldo | |
| | 2 | S. Lázaro | |
| | 3 | Tacon | |
| 5º | 1 | Guadalupe | |
| | 2 | Marte | |
| | 3 | Dragones | |
| 6º | 1 | Penalver | |
| | 2 | | |

| LA DIVISION GUBERNATIVA | | | |
|--------------------------------------------|-------------------|-----------------|--|
| mismos barrios, agrupados en 9 Distritos y | | | |
| Distritos | Nº de los barrios | Nombres | |
| 1º Distrito | 1 | Arsenal | |
| | 2 | Seiba | |
| | 3 | Jesus Maria | |
| | 4 | Viver | |
| | 5 | San Nicolas | |
| | 6 | Chavez | |
| 2º Distrito | 1 | Pilar | |
| | 2 | Altavés | |
| | 3 | Pueblo nuevo | |
| | 4 | Vedado | |
| | 5 | Príncipe | |
| 3º Distrito | 1 | Villanueva | |
| | 2 | Jesus del Monte | |
| | 3 | Lujano | |
| | 4 | Arroyo Apolo | |
| 4º Distrito | 1 | Cerro | |
| | 2 | Puentes grandes | |
| | 3 | Arroyo Narayón | |
| 5º Distrito | 1 | Caltario | |
| | 2 | | |

Puentes grandes, Arroyo Narayón y Caltario, no incluidas en los 9 Distritos.



DIRECTORIO

- | | |
|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| (1) Parul ^o del Ferro carril Urbano, en la plaza de S. Juan de Dios | Academia de ciencias medicas, fisicas y naturales. |
| (2) Cuartel de Municipales. | (11) Admon. de Correos - Intervencion de Marina - Deposito hidrográfico |
| (3) Gob. ^o cio ^l de la Provincia Adminis ^o de Loterias | (12) Comand. ^o gral del Apostadero |
| (4) Cuartel de la Fuerza | (13) Cuartelillo Bomb ^o municipales |
| (5) Tempete | (14) Cuartel Bomb ^o del Comercio |
| (6) Gobierno y Cap. ^o general - Ayunta - miento - Telégrafos | (15) Casa de Recogidas, de S. Juan Topomaceno |
| (7) Sto Domingo - Universidad - Instituto de 2. ^a enseñanza - Monte de piedad | (16) Carcel - Presidio Hospital civil de S. Felipe y Santiago |
| (8) Direccion de Hacienda - Orden. ^o de pagos - Tesoreria - Admon Eco - nomica | (17) Morgue o Necroscopio Obras municipales |
| (9) S. Felipe - Escuelas profesionales - Cuartel de Bomberos Municipales | (18) Asilo de S. Jose, de Artes y Oficios |
| (10) S. Agustin y su 3. ^a Orden. | (20) Teatro de Alhuxu, o de Lermundi Casino español |
| | (21) Cuartel de la Guardia civil |

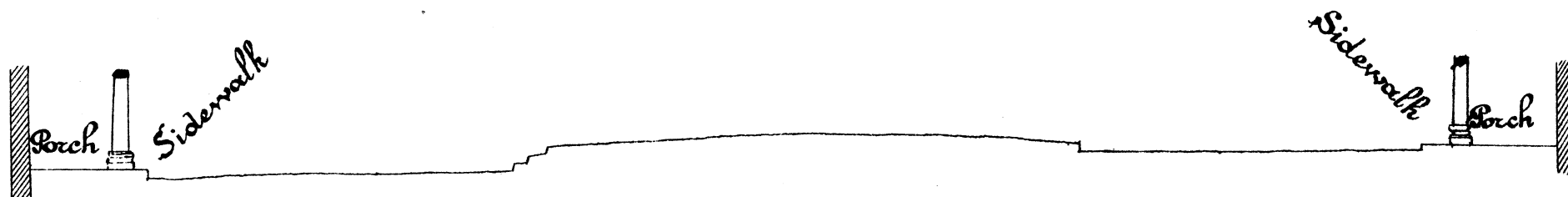
| DIVISION MUNICIPAL | | | | LA DIVISION GUBERNATIVA comprende los mismos barrios, agrupados en 9 Distritos y ordenados así. | | | |
|--------------------|-------------------------------|-----------------|-----------------|-------------------------------------------------------------------------------------------------|-----------------|-------------------------|-------------------------------|
| Distritos | N ^o de los barrios | Nombres | Distritos | N ^o de los barrios | Nombres | Distritos | N ^o de los barrios |
| 1 ^o | 1 | Tempete | 7 ^o | 1 | Arsenal | 1 ^o Distrito | 1 |
| | 2 | San Felipe | | 2 | Seiba | | 2 |
| | 3 | Santo Cristo | | 3 | Jesus Maria | | 3 |
| | 4 | S. Juan de Dios | | 4 | Vives | | 4 |
| | 5 | Angel | | 5 | San Nicolas | | 5 |
| | 6 | Casa Blanca | | 6 | Chavex | | 6 |
| 2 ^o | 1 | San Francisco | 8 ^o | 1 | Pilar | 2 ^o Distrito | 1 |
| | 2 | Santa Clara | | 2 | Atares | | 2 |
| | 3 | Santa Teresa | | 3 | Pueblo nuevo | | 3 |
| | 4 | Paula | | 4 | Vedado | | 4 |
| | 5 | S. Isidro | | 5 | Principe | | 5 |
| | 6 | Punta | | 6 | Villanueva | | 6 |
| 3 ^o | 1 | Colon | 9 ^o | 1 | Jesus del Monte | 3 ^o Distrito | 1 |
| | 2 | Monserate | | 2 | Luyano | | 2 |
| | 3 | S. Leopoldo | | 3 | Arroyo Apolo | | 3 |
| | 4 | S. Lazaro | | 4 | Puentes grandes | | 4 |
| | 5 | Tacon | | 5 | Arroyo Narayjo | | 5 |
| | 6 | Guadalupe | | 6 | Cabario | | 6 |
| 4 ^o | 1 | Marte | 10 ^o | 1 | Artesal | 5 ^o Distrito | 1 |
| | 2 | Dragones | | 2 | Seiba | | 2 |
| | 3 | Penalver | | 3 | Jesus Maria | | 3 |
| | 4 | | | 4 | Vives | | 4 |
| | 5 | | | 5 | S. Nicolas | | 5 |
| | 6 | | | 6 | Penalver | | 6 |
| 5 ^o | 1 | | | 1 | Chavex | 6 ^o Distrito | 1 |
| | 2 | | | 2 | Pilar | | 2 |
| | 3 | | | 3 | Atares | | 3 |
| | 4 | | | 4 | S. Lazaro | | 4 |
| | 5 | | | 5 | Pueblo nuevo | | 5 |
| | 6 | | | 6 | Principe | | 6 |
| 6 ^o | 1 | | | 1 | Vedado | 7 ^o Distrito | 1 |
| | 2 | | | 2 | Jesus del Monte | | 2 |
| | 3 | | | 3 | Luyano | | 3 |
| | 4 | | | 4 | Arroyo Apolo | | 4 |
| | 5 | | | 5 | Villanueva | | 5 |
| | 6 | | | 6 | Cerro | | 6 |

| DIVISION JUDICIAL | |
|---------------------------------------|--------------------------------------|
| Distrito de la Catedral, comprende el | 1 ^o Municipal |
| Belen | 2 ^o Idem |
| Monserate | 3 ^o y 4 ^o Idem |
| Guadalupe | 5 ^o y 6 ^o Idem |
| Jesus Maria | 7 ^o y 8 ^o Idem |
| Pilar | 9 ^o Idem |
| Cerro | 10 ^o Idem y Mariano |

Office of Chief Engineer
Division of Cuba.
To accompany Report of June 30th, 1900.
M. M. Clark
Major Corps of Engineers, U.S.A.
Chief Engineer Division of Cuba.



Prado between Genios and Corcel



Prado between Neptuno and Virtudes

2 1 2 3 4 5 6 7 8 9 10 Piers

SURVEYS FOR THE ESTABLISHMENT OF STREET GRADES.

Throughout the city evidences of lack of attention to street grades with relative curb elevations are evident. A good example of this is to be seen in the cross-section photograph of the north end of the Prado.

The lack of a map showing with accuracy the occupied portion of the city, and the necessity of obtaining such data for the intelligent laying of street and sewer grades, caused the inauguration, during the latter portion of the fiscal year 1899, of a survey of the built-up portion of the city. This work has been in progress throughout the current fiscal year, and during the last six months has received especial attention. Since February, 1900, these surveys have been under the direction of Mr. C. C. Fitzgerald, assistant engineer. The average number of field parties has been five, but by reason of the advanced stage of the work, the number has been reduced to three. The work has been carried on with the object of showing all actual building occupation, curb lines, telephone, telegraph, and electric-light poles, sewer inlets, water plugs, street, curb, and floor levels. The ordinary engineer's transit has been employed in conjunction with standardized steel tapes and spring balances. As will be seen from plate 44, the major portion of the field work has been completed. All main transverse lines and subsidiary lines for filling in have been computed by the method of rectangular coordinates. The maximum error of closure is 1.12340, the minimum error of closure is 1.71000, the average error of closure is 1.26790. No attempt has as yet been made to make an accurate survey of the block subdivisions.

CITY SHOPS, LOS FOSOS.

[Mr. Fernando Mendez, superintendent.]

The city shops at Los Fosos, where a very large portion of the repair work of the engineer department, city fire department, and the sanitary service of the city has been done, are in old buildings in advanced state of decay, and are provided with a very limited amount of machinery, which is all of antiquated type. Photographs giving general views of shops and stable No. 1 are shown in plate 47, in which can be seen, as forming the outside wall of one of the buildings, the largest and best preserved portion of the old city wall which now exists.

Notwithstanding the lack of proper facilities for the execution of repairs, the character of work done at Los Fosos has been good. The cost has necessarily been high, but this has been materially reduced within the past calendar year.

The fact that several hundred reconcentrados have until very recently lived within the Fosos inclosure, and that the city cattle pound has been located there, has made difficult the obtaining of good results.

CITY STABLES No. 1.

[Mr. Fernando Mendez, superintendent July 1 to December 31, 1899; Mr. J. C. Duncan, superintendent January 1 to June 30, 1900.]

This stable is located within the Fosos inclosure. All department animals used in street construction and repair, together with those used in sanitary disinfection work, city ambulance service, and a por-

tion of the transportation of the water department have been kept at this stable.

On May 10, 18 of the mules originally received by the department as property of the former city government, together with 4 ambulances, and harness, were transferred to the chief of municipal sanitary service for use in connection with hospital work. Stable No. 1 was also turned over for use by that department, and all other animals, wagons, harness, etc., pertaining to stable No. 1 were transferred to stables Nos. 2 and 3.

The number of animals and the average daily cost per animal for forage and care to the end of April are shown in the following table:

Maintenance report of animals at stable No. 1.

Animals maintained per month.

| Month. | Horses. | Mules. | Oxen. | Total. | Average daily cost. | Average monthly cost. | Total monthly cost. |
|-----------------|---------|--------|-------|--------|---------------------|-----------------------|---------------------|
| July | 18 | 67 | 27 | 112 | \$0.598 | \$17.984 | \$1,903.09 |
| August | 19 | 85 | 23 | 127 | .535 | 16.066 | 2,003.69 |
| September | 18 | 80 | 25 | 123 | .526 | 15.797 | 1,940.35 |
| October | 17 | 84 | 24 | 125 | .575 | 17.238 | 2,154.84 |
| November | 15 | 84 | 24 | 123 | .557 | 16.726 | 2,061.90 |
| December | 41 | 81 | 24 | 146 | .677 | 20.319 | 2,504.28 |
| January | 46 | 80 | 20 | 146 | .424 | 12.743 | 1,838.73 |
| February | 52 | 78 | 20 | 150 | .416 | 12.489 | 1,873.43 |
| March | 54 | 77 | 21 | 152 | .408 | 11.66 | 1,772.78 |
| April | 42 | 73 | 21 | 136 | .428 | 12.84 | 1,778.78 |

GENERAL.

On April 30, Habana's 180 kilometers of streets may be classified as follows:

| | Lineal meters. | Lineal miles. | Percentage. |
|-----------------------|----------------|---------------|-------------|
| Belgian block | 39,033 | 24.25 | 21.64 |
| Boston block | 4,016 | 2.49 | 2.33 |
| Asphalt block | 1,070 | .66 | .60 |
| Vitrified brick | 240 | .15 | .13 |
| Sheet asphalt | 103 | .06 | .05 |
| Cobble | 333 | .21 | .20 |
| Macadam | 100,515 | 62.46 | 55.79 |
| Wooden block | 55 | .03 | .03 |
| Unpaved | 34,640 | 21.53 | 19.23 |
| Total | 180,005 | 111.84 | 100.00 |

The location of the various classes of streets is shown on plate 48.

Sixty-nine per cent of the paved streets of the city have at one time been macadamized; 15 per cent of these are still in an almost impassable condition, but are being put in good order, as rapidly as the reduced amount of funds available will permit.

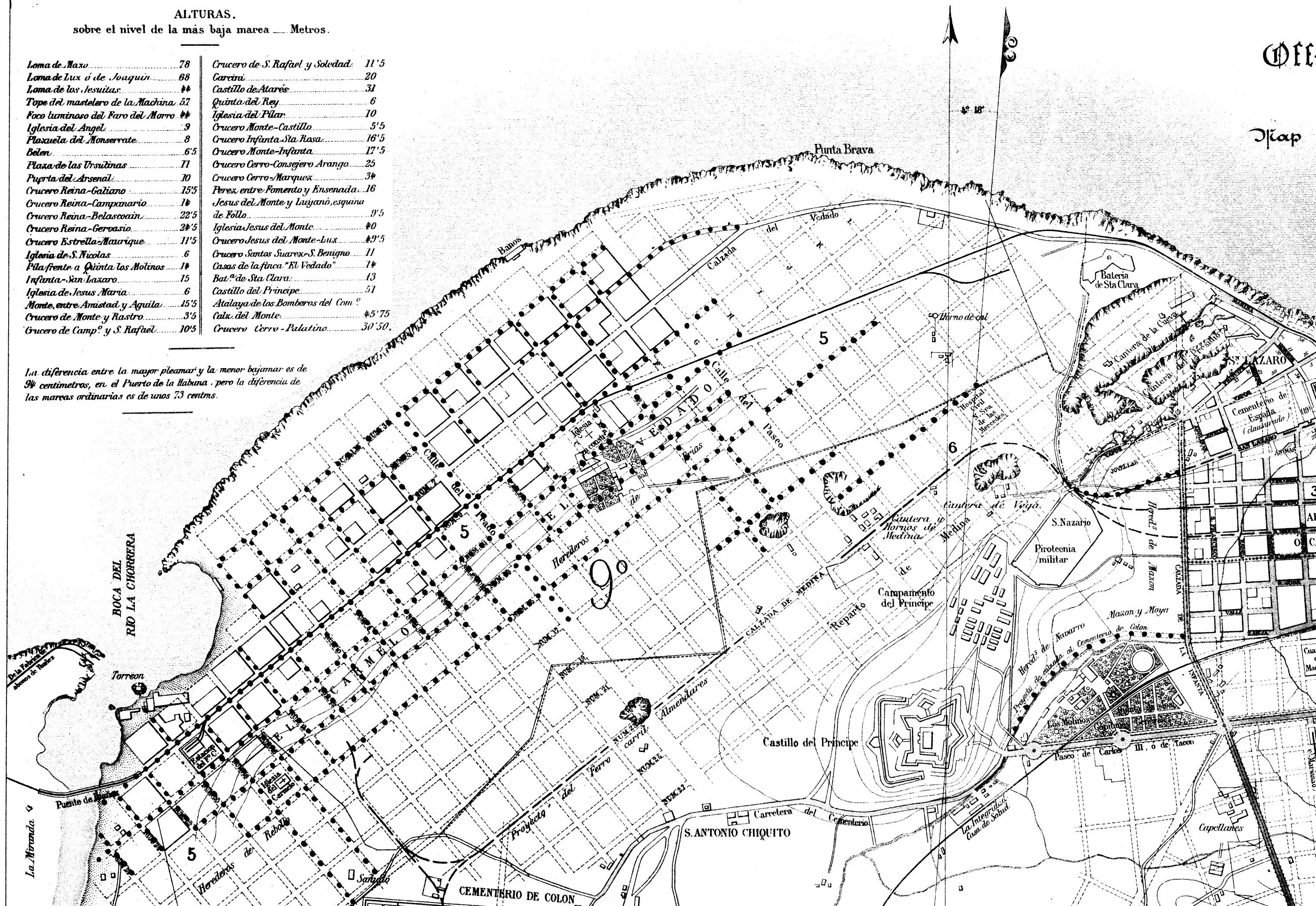
The unpaved streets, as a rule, are fully built up by residences, and have been in their present stage in nearly all instances for many years.

While conditions have prevented the construction of modern permanent pavements, one advantage has attended the execution of the considerable amount of macadam work, which might be lost sight of;

ALTURAS.
sobre el nivel de la más baja marea — Metros.

| | | | |
|---------------------------------------|------|----------------------------------------------------|-------|
| Loma de Maxo..... | 78 | Crucero de S. Rafael y Soledad..... | 11'5 |
| Loma de Lux o de Jouguin..... | 68 | Carcara..... | 20 |
| Loma de los Jesuitas..... | 44 | Castillo de Atarés..... | 31 |
| Tope del mastelero de la Machina..... | 57 | Quinta del Rey..... | 6 |
| Foco luminoso del Faro del Morro..... | 44 | Iglesia del Pilar..... | 10 |
| Iglesia del Angel..... | 9 | Crucero Monte-Castillo..... | 5'5 |
| Plazuela del Monserrate..... | 8 | Crucero Infanta Sta Rosa..... | 16'5 |
| Belen..... | 6'5 | Crucero Monte-Infanta..... | 17'5 |
| Plaza de las Ursulinas..... | 71 | Crucero Cerro-Consuegro Arango..... | 25 |
| Puerta del Arsenal..... | 70 | Crucero Cerro-Marquez..... | 34 |
| Crucero Reina-Galiano..... | 15'5 | Perez, entre Fomento y Ensenada..... | 16 |
| Crucero Reina-Campanario..... | 14 | Jesus del Monte y Luzano, esquina de Follo..... | 9'5 |
| Crucero Reina-Belascosain..... | 22'5 | Iglesia Jesus del Monte..... | 40 |
| Crucero Reina-Gervasio..... | 24'5 | Crucero Jesus del Monte-Lux..... | 49'5 |
| Crucero Estrella-Maurique..... | 11'5 | Crucero Santos Suarez-S. Benigno..... | 11 |
| Iglesia de S. Nicolas..... | 6 | Casas de la finca "El Vedado"..... | 14 |
| Pila frente a Quinta los Molinos..... | 14 | Bat.ª de Sta Clara..... | 13 |
| Infanta-San Laxaro..... | 75 | Castillo del Principe..... | 51 |
| Iglesia de Jesus Maria..... | 6 | Atalaya de los Bomberos del Com.º..... | |
| Monte, entre Amistad y Aguila..... | 15'5 | Calx. del Monte..... | 45'75 |
| Crucero de Monte y Rastro..... | 3'5 | Crucero Cerro-Pulativo..... | 30'50 |
| Crucero de Camp.º y S. Rafael..... | 10'5 | | |

La diferencia entre la mayor pleamar y la menor bajamar es de
94 centímetros, en el Puerto de la Habuna, pero la diferencia de
las mareas ordinarias es de unos 73 centms.

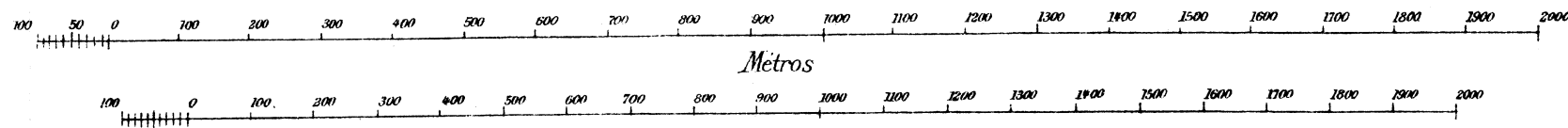


Map showing occupied Streets paved
and unpaved.

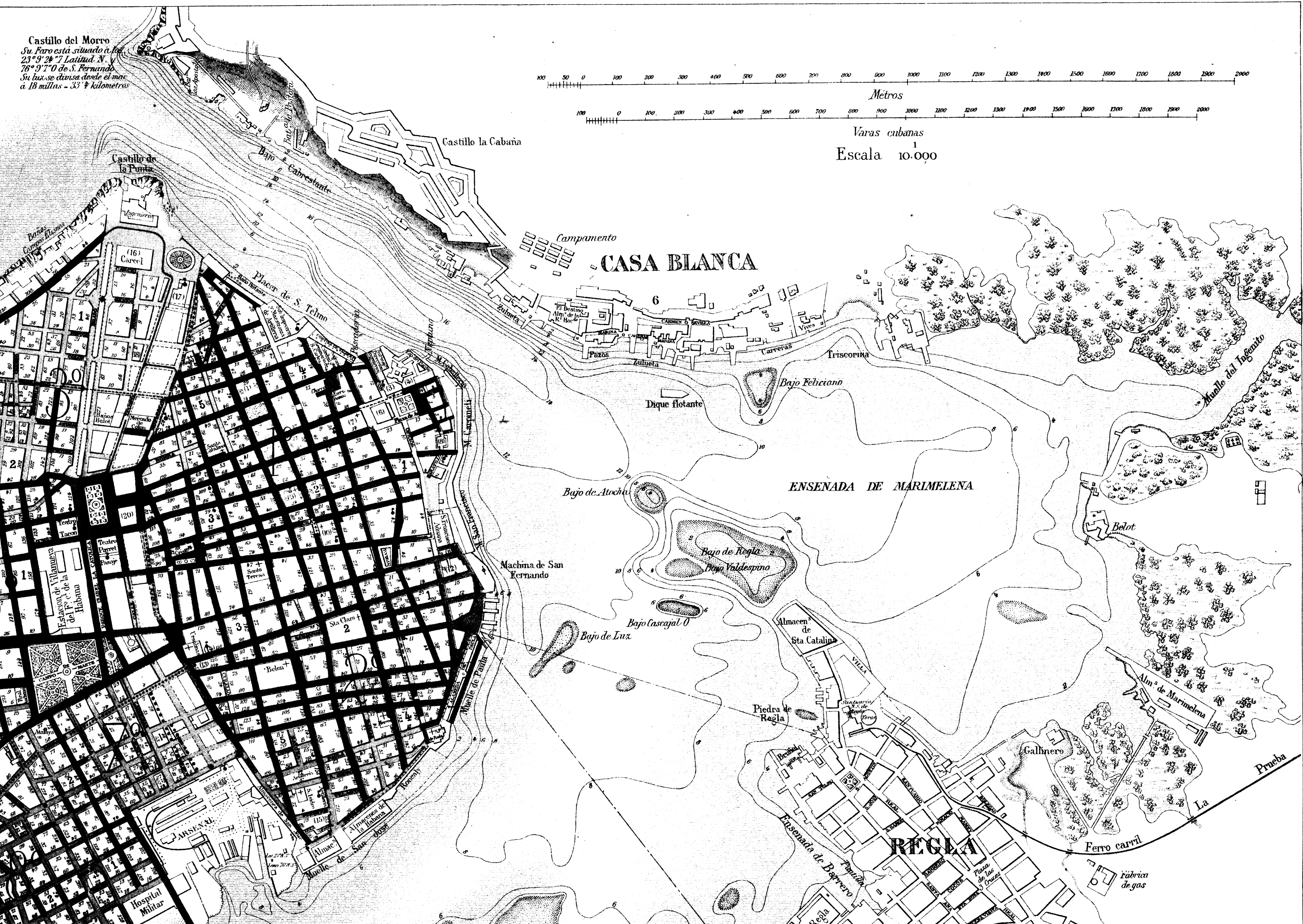
[illegible]

CASA BLANCA

Castillo del Morro
Su Faro está situado a las
23°9'24"7 Latitud N. y
76°9'7"0 de S. Fernando
Su luz se divisa desde el mar
a 18 millas - 33 1/4 kilometros



Varas cubanas
Escala 10.000¹





9°

6

Alma de las Animas

Puente de Villavieja

Matadero

Atares

Puente de Chaves

Puente de Cristina

Estacion de Cristina

Castillo de Atares

ENSENADA DE ATARES

Cayo Cruz o Cayo Pulo

Cayo Blanco

Almacén de pólvora S. Antonio

Almacenes de Hacendados

Almacén de pólvora S. Felipe y S. Jose

Quinta del Rey

Quinta de D. M. Ferrer

Quinta de D. M. Ferrer

Quinta de D. M. Ferrer

Quinta de D. M. Ferrer

Quinta de D. M. Ferrer

Quinta de D. M. Ferrer

Quinta de D. M. Ferrer

Quinta de D. M. Ferrer

Quinta de D. M. Ferrer

Quinta de D. M. Ferrer

Quinta de D. M. Ferrer

Quinta de D. M. Ferrer

Quinta de D. M. Ferrer

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Quinta de D. M. Ferrer

Quinta de D. M. Ferrer

Quinta de D. M. Ferrer

Quinta de D. M. Ferrer

Quinta de D. M. Ferrer

CERRO

BUENOS AIRES

BUENOS AIRES

BUENOS AIRES

BUENOS AIRES

BUENOS AIRES

BUENOS AIRES

BUENOS AIRES

CONCHA

2

10°

Rio Luyano

Chico o America de D.M. de Embil

Tegar

Puente de Pastrana

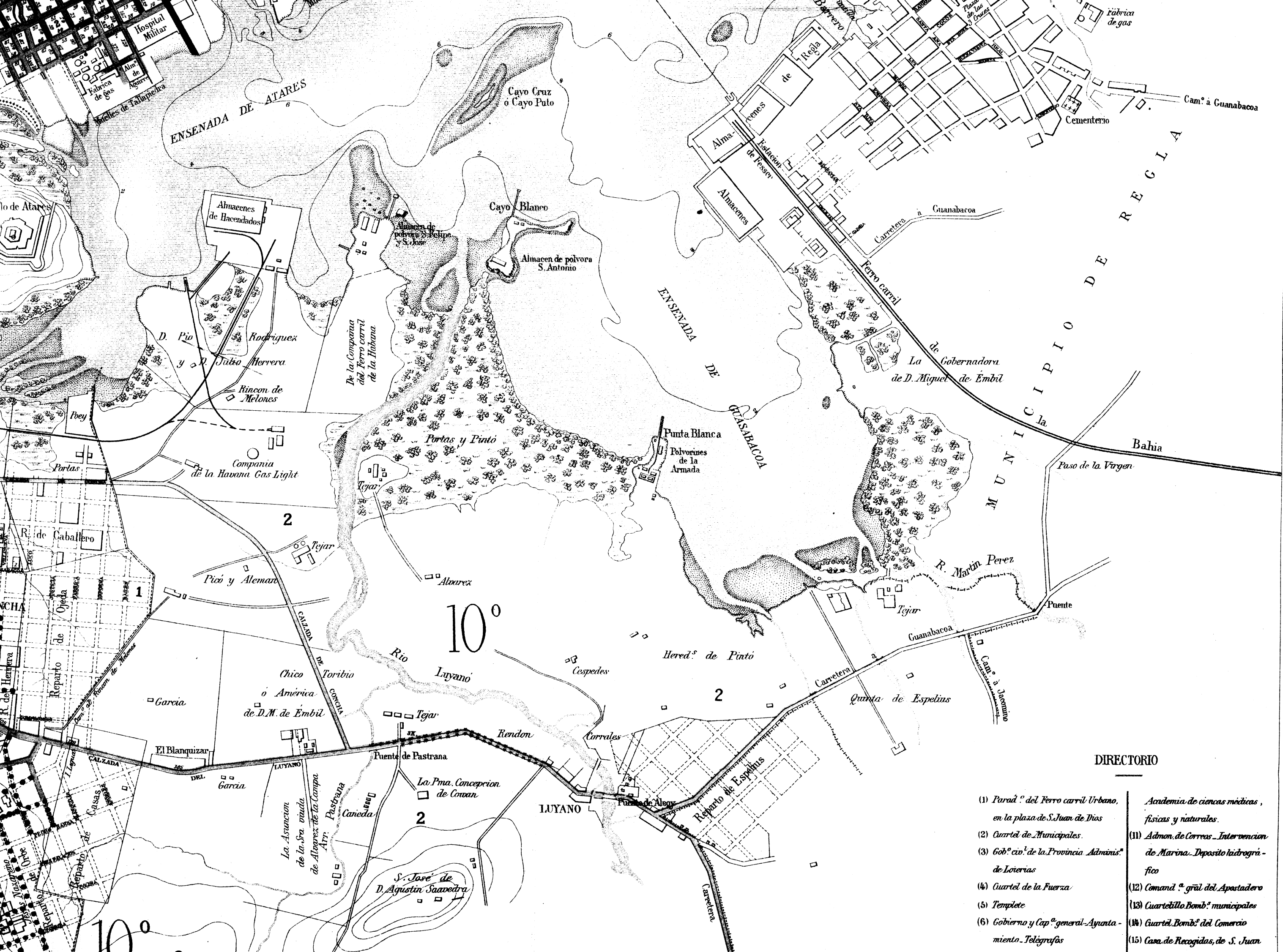
La Pma. Concepcion de Conan

2

S. Jose de D. Agustin Saavedra

LUYANO

10°



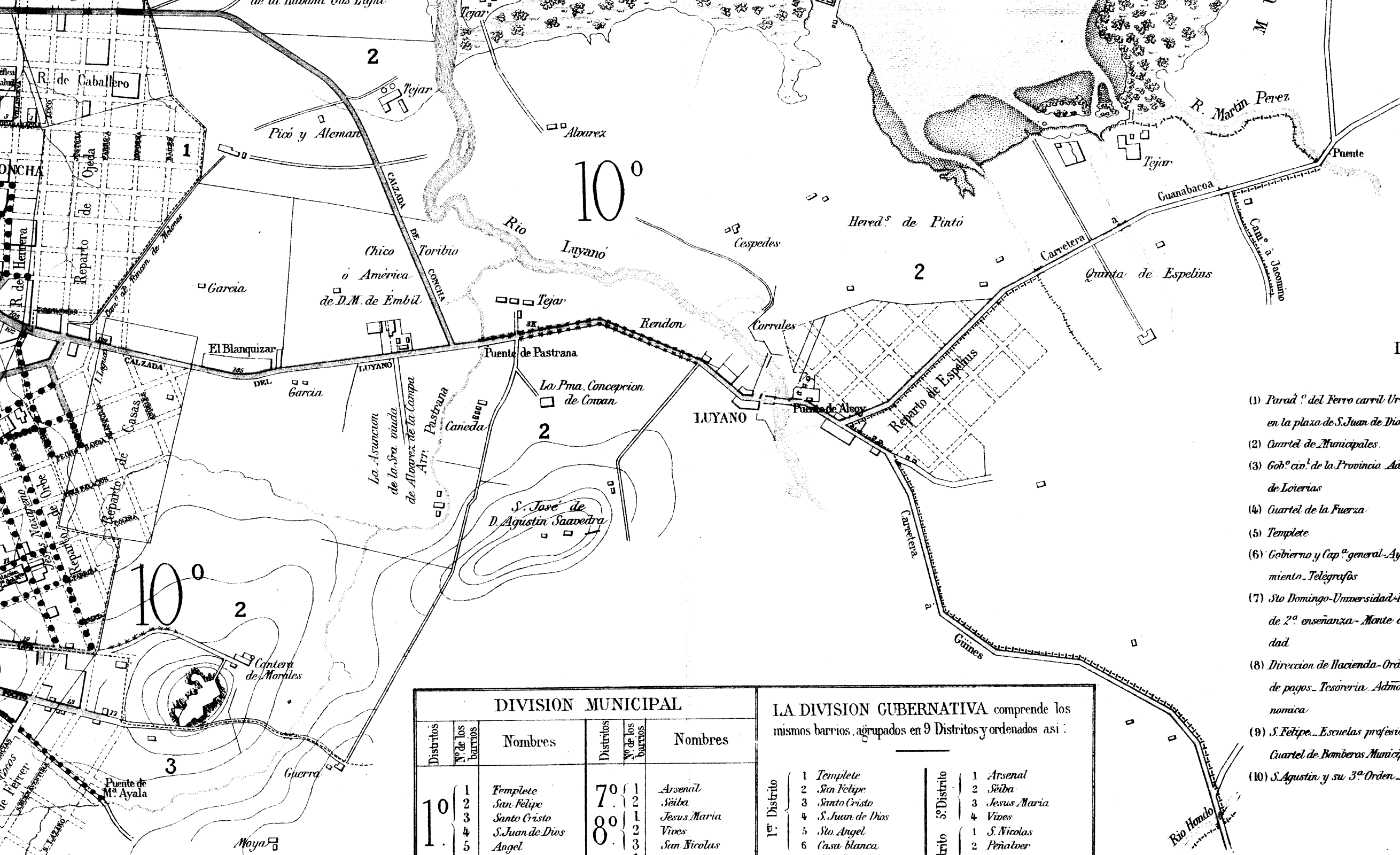
DIRECTORIO

- | | |
|-------------------------------------------------------------------|-------------------------------------------------------------------------|
| (1) Parada del Ferrocarril Urbano, en la plaza de S. Juan de Dios | Academia de ciencias médicas, físicas y naturales. |
| (2) Cuartel de Municipales. | (11) Admon. de Correos - Intervención de Marina - Deposito hidrográfico |
| (3) Gob. civ. de la Provincia - Adminis. de Licerias | (12) Comand. en jefe del Apostadero |
| (4) Cuartel de la Fuerza | (13) Cuartelillo Bomb. municipales |
| (5) Templo | (14) Cuartel Bomb. del Comercio |
| (6) Gobierno y Cap. general - Ayuntamiento - Telégrafos | (15) Casa de Recogidas, de S. Juan |

HABANA

EDITOR: D. JOSE VALDEPARES.

[illegible]



DIRECTORIO

- (1) Paród. del Ferro carril Urbano, en la plaza de S. Juan de Dios
- (2) Cuartel de Municipales
- (3) Gob.º cio.º de la Provincia. Adminis.º de Loterías
- (4) Cuartel de la Fuerza
- (5) Tempete
- (6) Gobierno y Cap.º general Ayunta. miento. Telégrafos
- (7) Sto Domingo-Universidad-Instituto de 2.º enseñanza- Monte de piedad
- (8) Direccion de Hacienda-Orden.º de pagos. Tesoreria. Admon. Eco. nomica
- (9) S. Felipe. Escuelas profesionales. Cuartel de Bomberos Municipales
- (10) S. Agustín y su 3.º Orden.
- Academia de ciencias médicas, físicas y naturales.
- (11) Admon. de Correos. Intervencion de Marina. Deposito hidrográ. fico
- (12) Comand.º gral del Apostadero
- (13) Cuartelillo Bomb.º municipales
- (14) Cuartel Bomb.º del Comercio
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- (16) Carcel. Presidio Hospital civil de S. Felipe y Santiago
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- (18) Asilo de S. José, de Artes y Oficios
- (20) Teatro de Albizu, ó de Lermundi. Casino español
- (21) Cuartel de la Guardia civil

| DIVISION MUNICIPAL | | | | LA DIVISION GUBERNATIVA comprende los mismos barrios, agrupados en 9 Distritos y ordenados así: | | | |
|--------------------|-------------------|-----------------|-----------|-------------------------------------------------------------------------------------------------|-----------------|-------------|-------------------|
| Distritos | Nº de los barrios | Nombres | Distritos | Nº de los barrios | Nombres | Distritos | Nº de los barrios |
| 1º | 1 | Tempete | 7º | 1 | Arsenal | 5º Distrito | 1 |
| | 2 | San Felipe | | 2 | Seiba | | 2 |
| | 3 | Santo Cristo | | 3 | Jesus Maria | | 3 |
| | 4 | S. Juan de Dios | 8º | 1 | Vicos | | 4 |
| | 5 | Angel | | 2 | San Nicolas | | 1 |
| | 6 | Casa blanca | | 3 | Chavex | | 2 |
| 2º | 1 | San Francisco | 9º | 1 | Pilar | 6º Distrito | 1 |
| | 2 | Santa Clara | | 2 | Alarés | | 2 |
| | 3 | Santa Teresa | | 3 | Pueblo nuevo | | 3 |
| 3º | 4 | Paula | 10º | 4 | Vedado | 7º Distrito | 4 |
| | 5 | S. Isidro | | 5 | Príncipe | | 1 |
| | 6 | Villanueva | | 6 | Jesus del Monte | | 2 |
| 4º | 1 | Colon | | 7 | Luyano | 8º Distrito | 3 |
| | 2 | Monserate | | 8 | Arroyo Apolo | | 4 |
| | 3 | S. Leopoldo | | 9 | Puentes grandes | | 1 |
| 5º | 1 | S. Lazaro | | 6 | Arroyo Naranjo | | 2 |
| | 2 | Tacon | | 7 | Calvario | | 3 |
| | 3 | Guadalupe | | | | | |
| 6º | 1 | Marte | | | | | |
| | 2 | Dragones | | | | | |
| | 3 | Peñalver | | | | | |

Puentes grandes, Arroyo Naranjo y Calvario estaban como Pedanías, no incluidas en los 9 Distritos.

Office of Chief Engineer
Division of Cuba.

To accompany Report of June 30th, 1900.

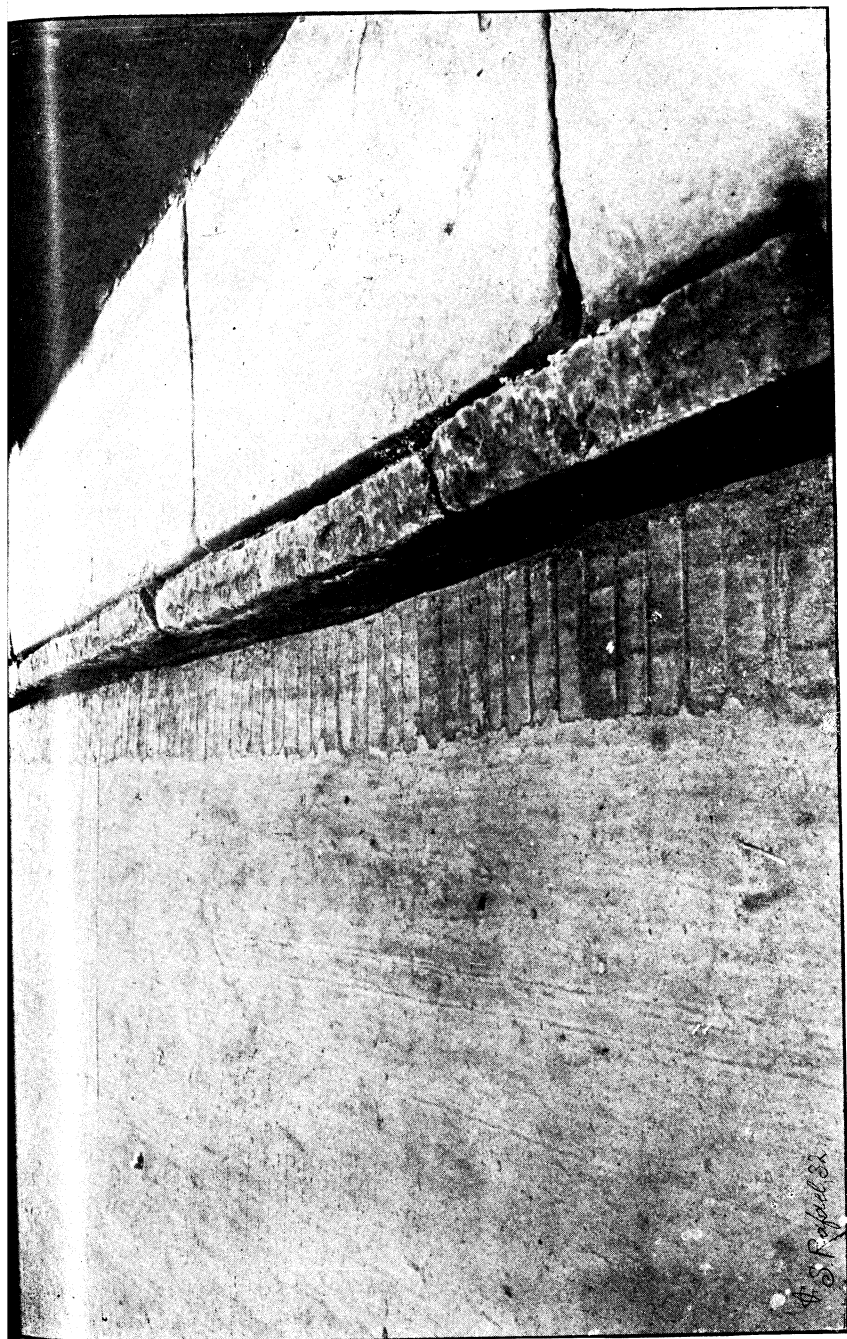
W. M. Rush

Major Corps of Engineers, U.S.A.
Chief Engineer Division of Cuba.

Index.

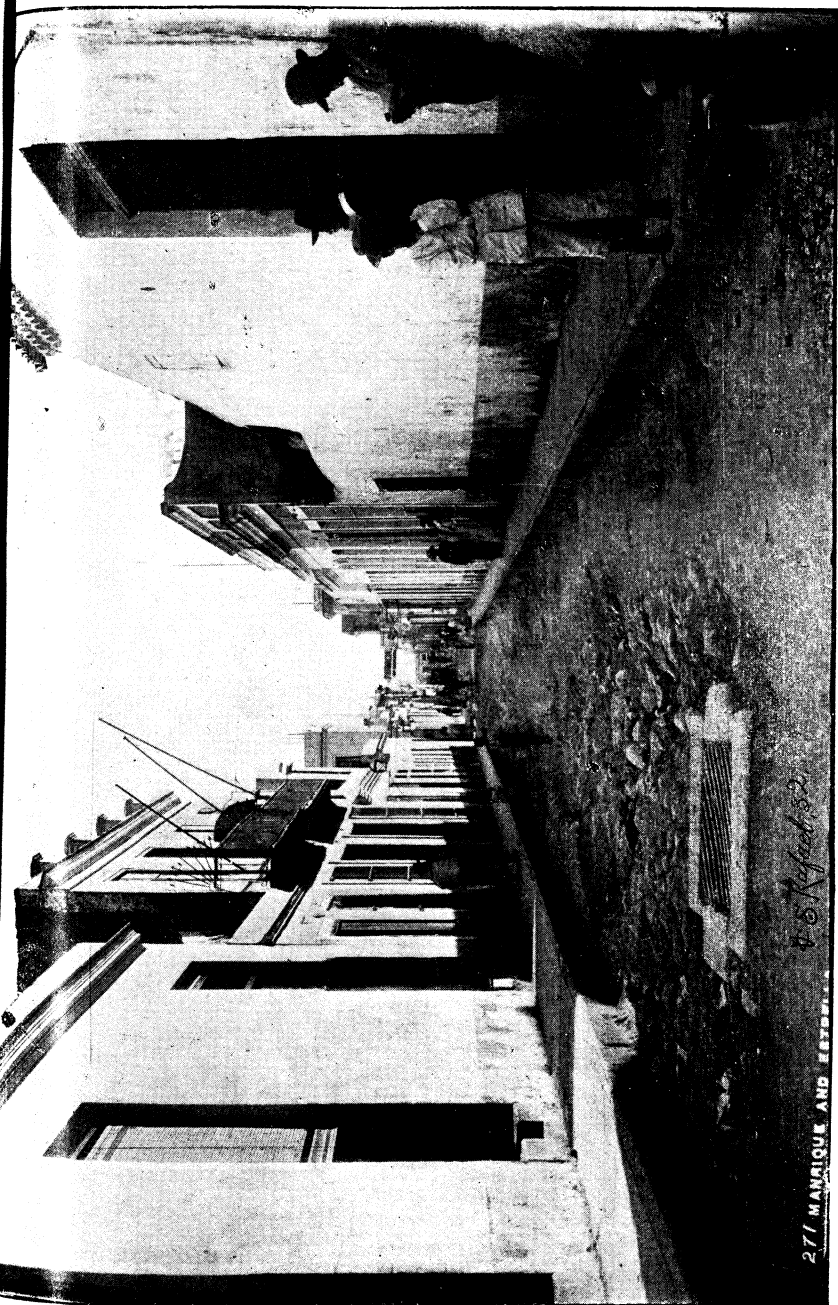
- Macadam
- Belgian Block
- Boston Block
- Asphalt Block
- Asphalt Sheet
- Brick
- Wooden Block
- Cobble
- Unpaved





CHURRUCÁ ASPHALT BLOCK, VITRIFIED BRICK GUTTER.

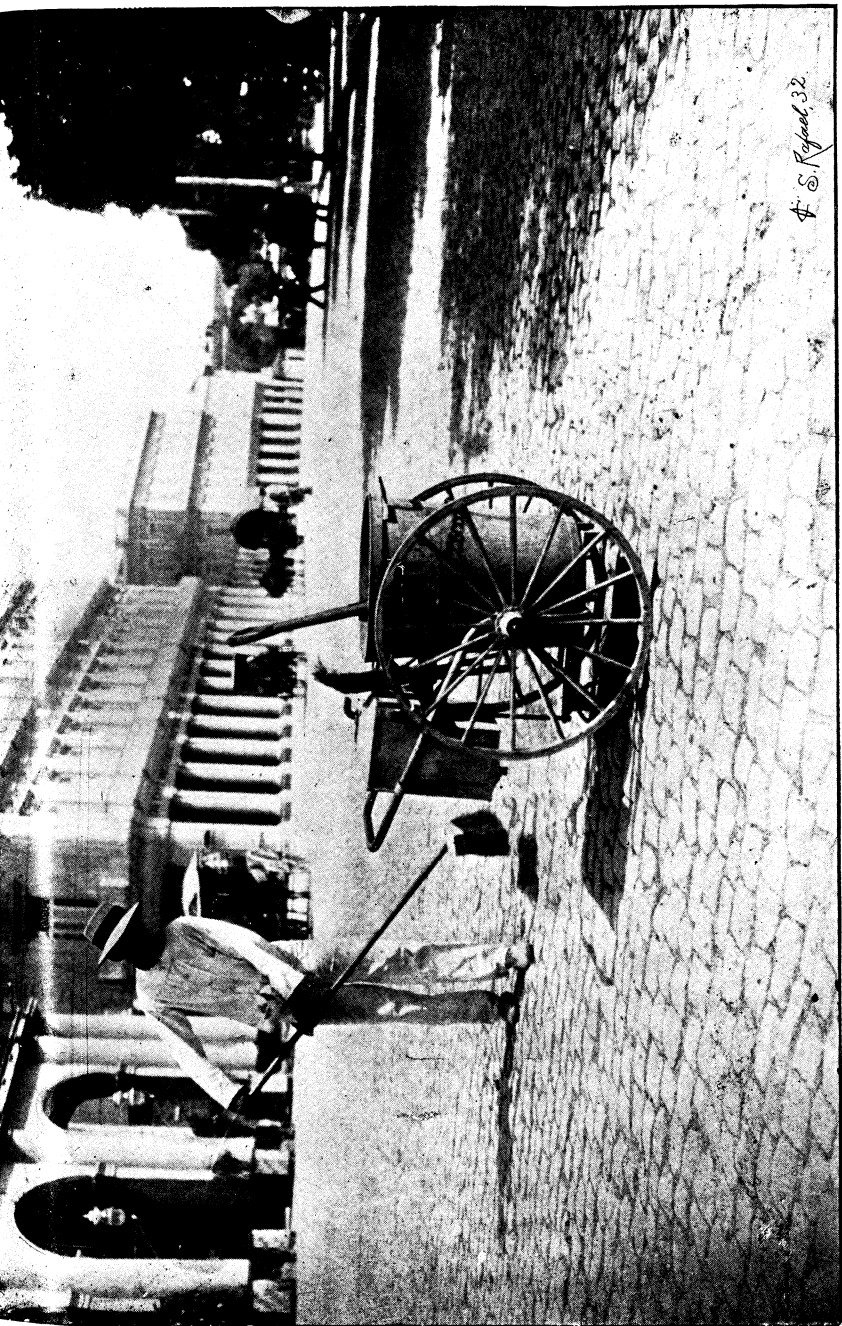
4. S. Robert. 32.



271 HANRIQUE AND ESTERIL

45 Ref. 32

CITY SEWER INLETS.



S. Rafael 32

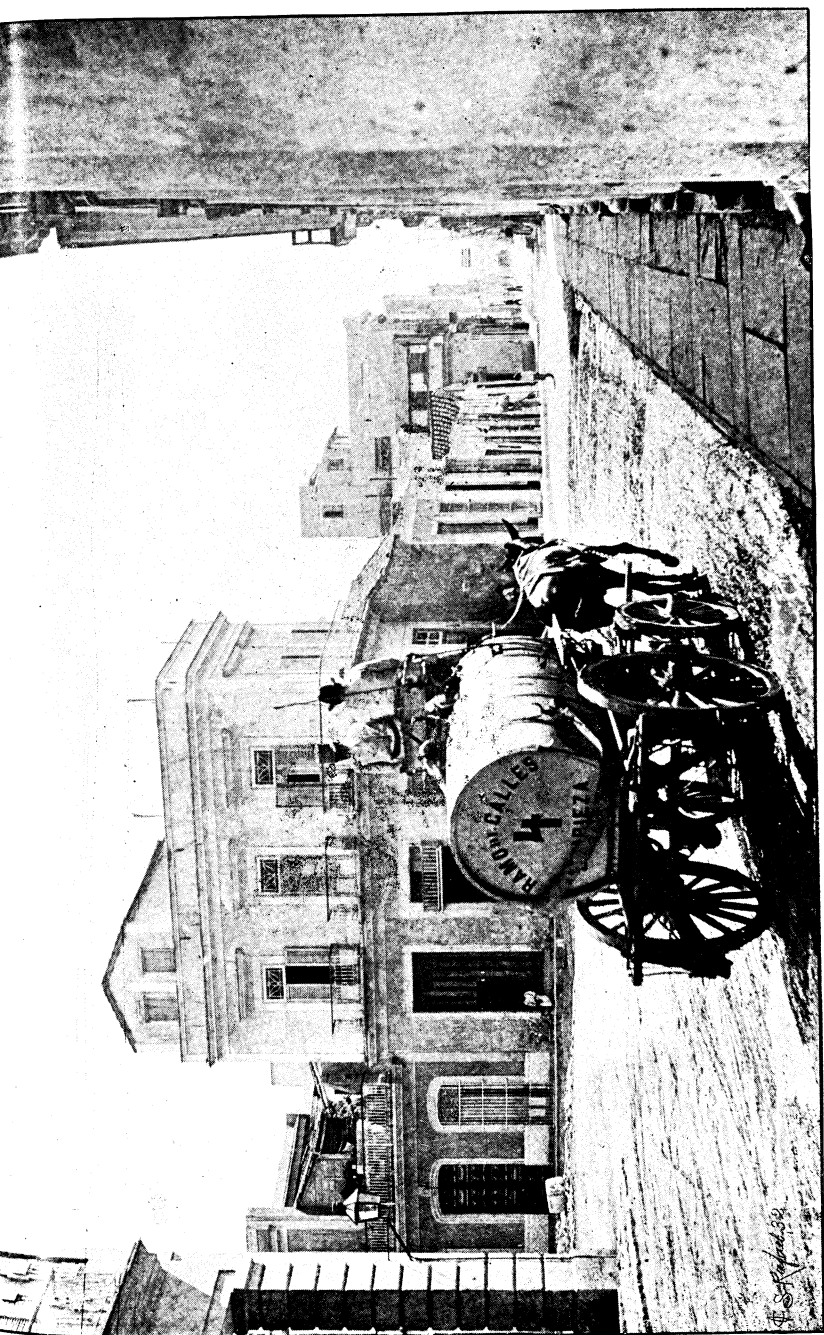
SMALL PUSH CART. USED BY STREET SWEEPERS. JUNE 30, 1900.



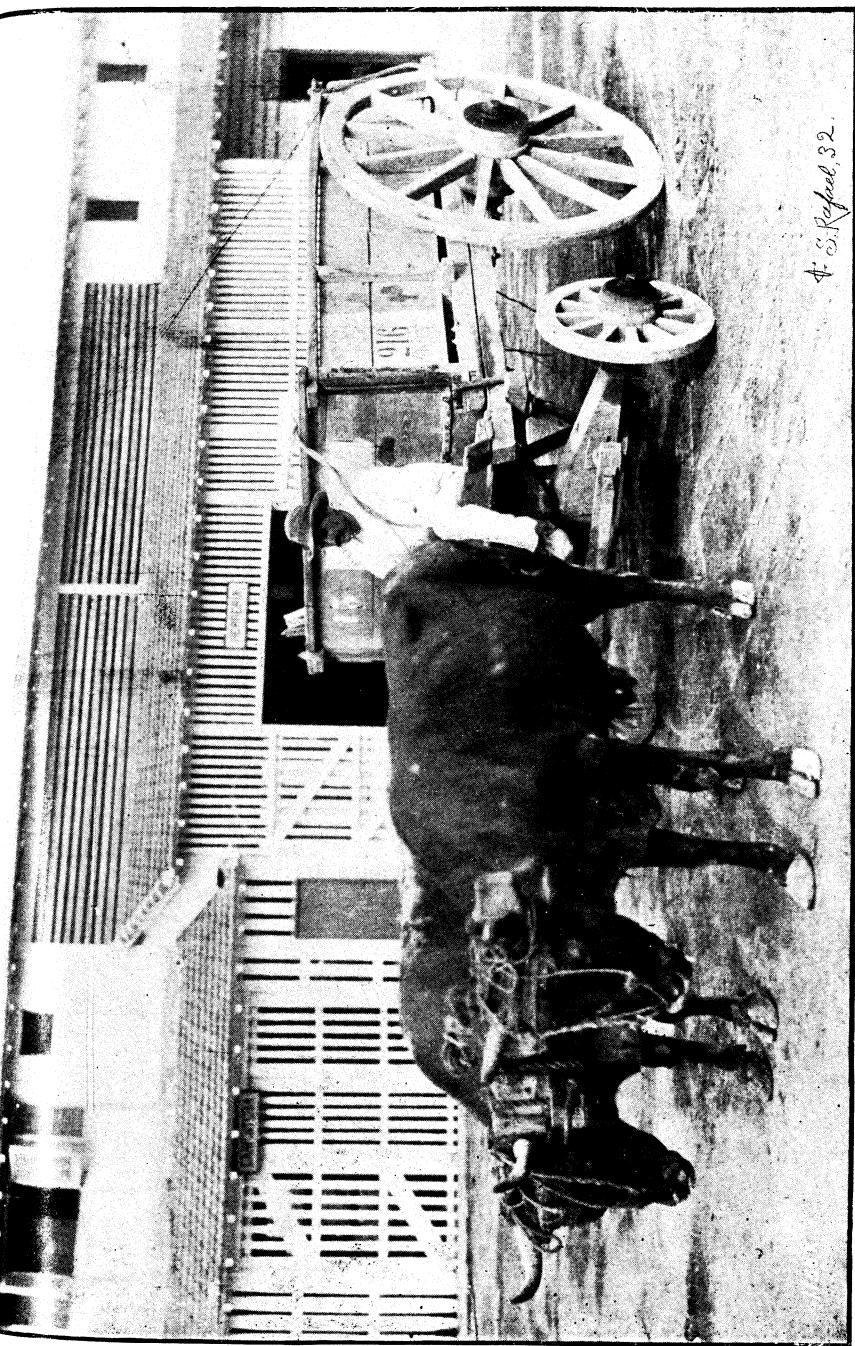


H. S. Ryland 32

INSPECTOR'S CART.

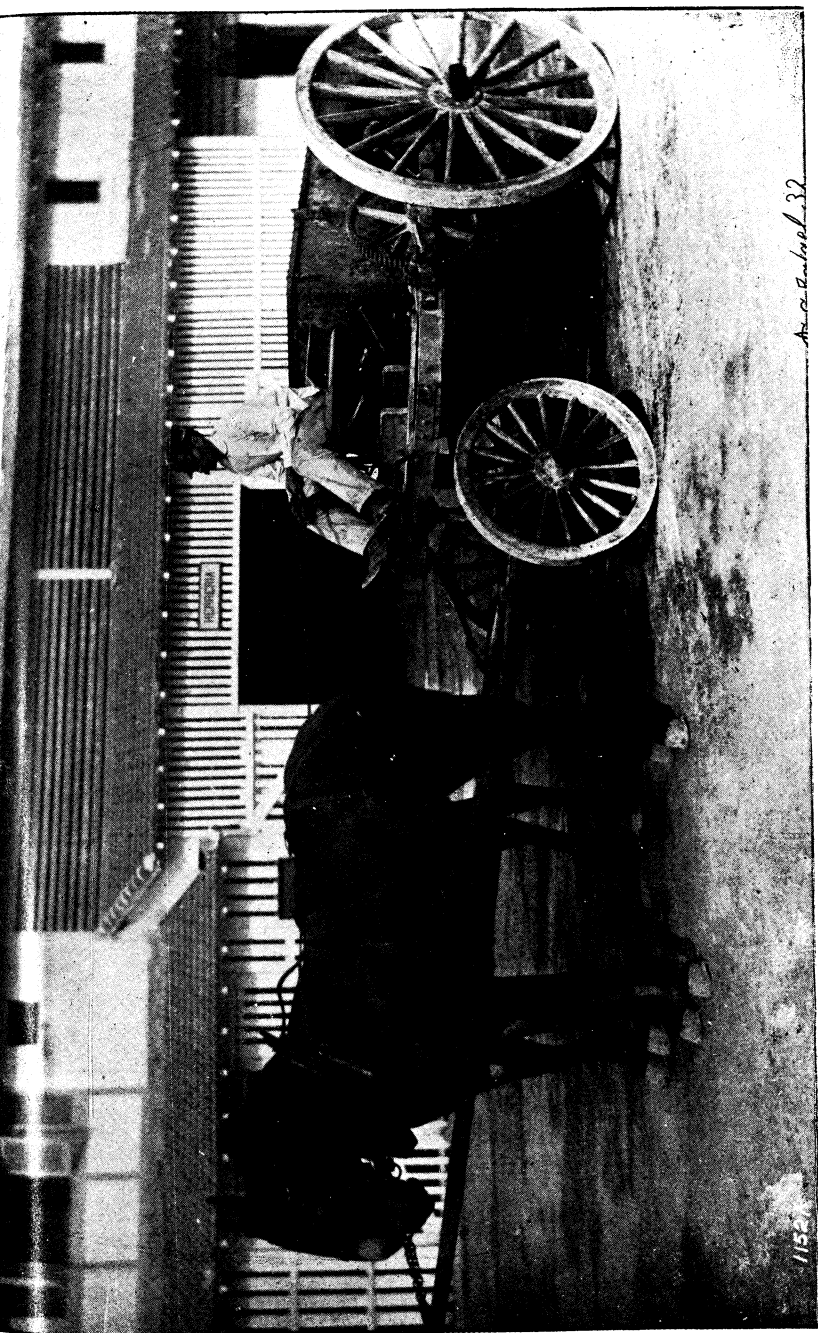


500-GALLON SPRINKLING WAGON.



H. S. Rapel, 32.

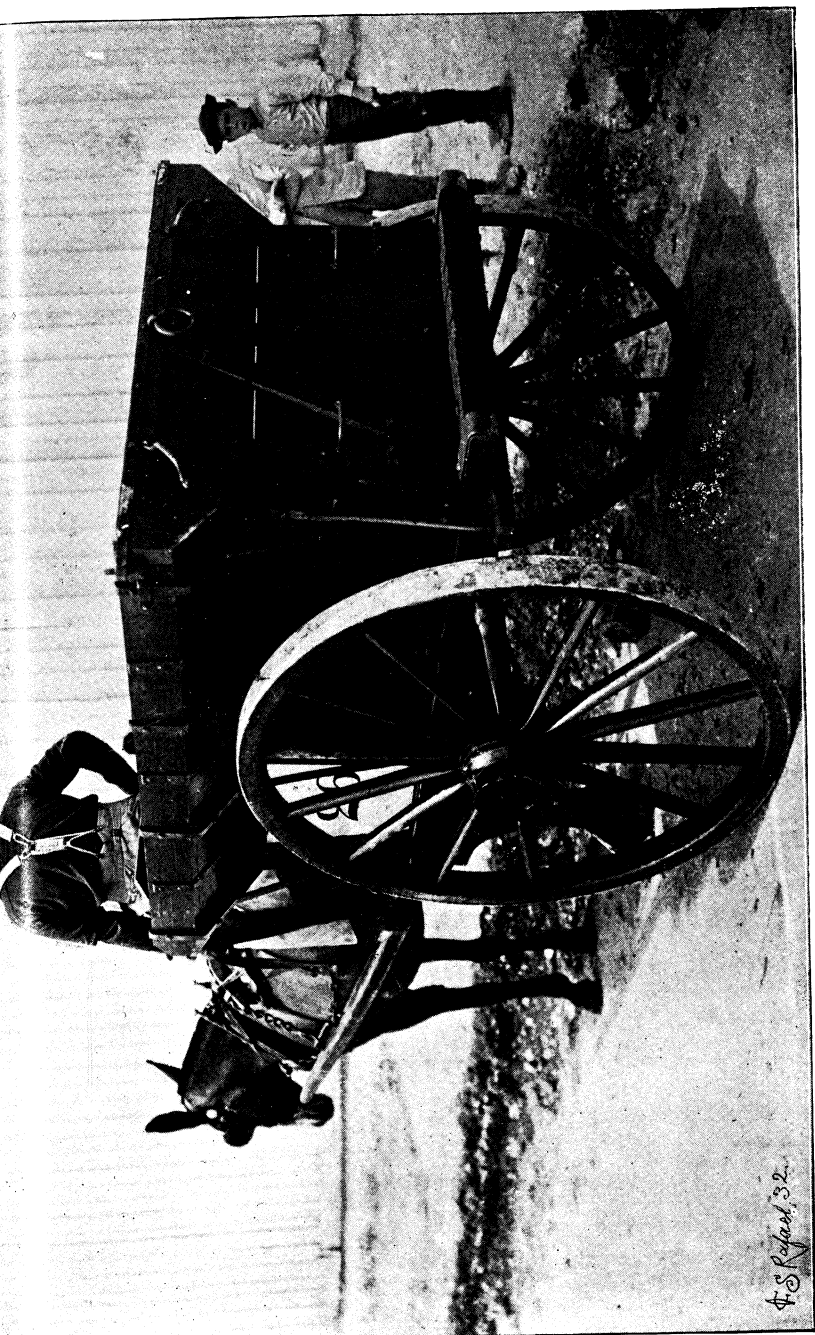
OLD DUMP CART.



NEW STYLE SANITARY CART.

As a whole 32

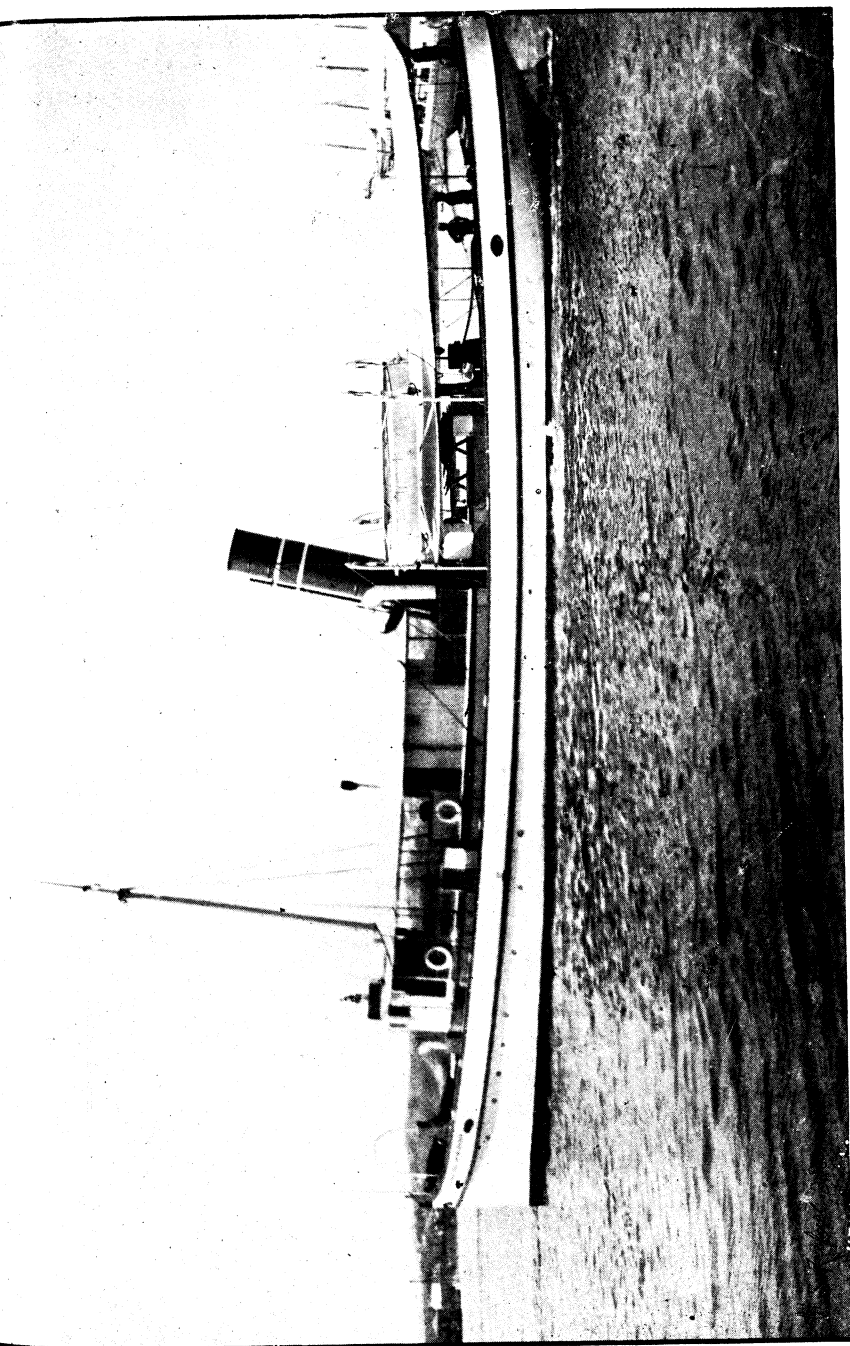
1152



4 S Refuse 32

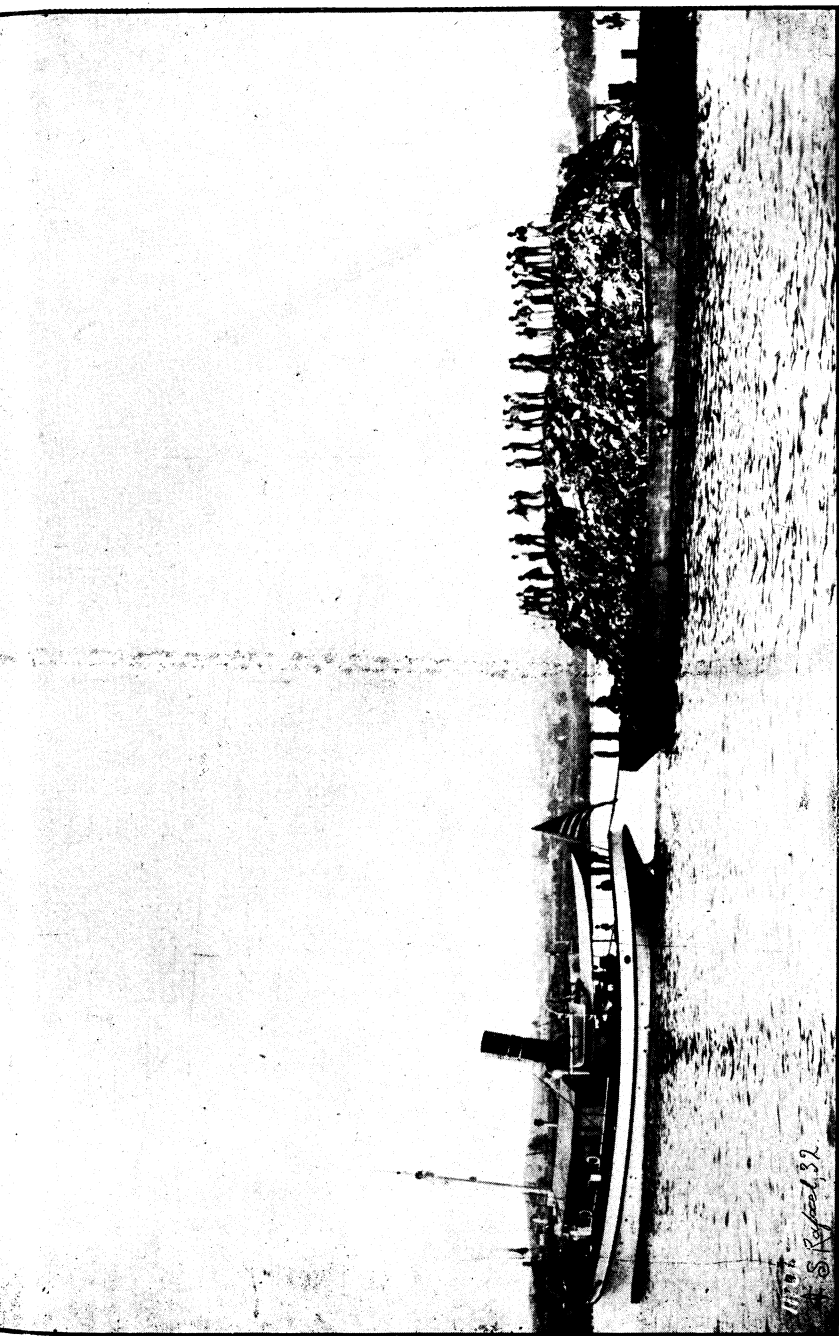
REMODELED REFUSE CART; CAPACITY 60 CUBIC FEET. JUNE 1, 1900.





DEPARTMENT TUG "NARCISO DEULOFEU."





STARTING TO SEA WITH REFUSE:

11/10/17
S. Refuse 137



the fact that all money expended in such construction has been paid out in Habana at a time when private industries were severely crippled. The organization of the work has shown a continuous improvement, and it is believed to be very largely due to the rigid adoption of the merit system. Every laborer knows that promotions are made entirely from the ranks, and that when promoted he must fulfill the duties of his higher position in a creditable manner or be discharged. The Cuban laborer, under proper supervision, gives good service. It has been extremely difficult to obtain good foremen, and the training of men for these positions is not accomplished in any brief period. A considerable number of good foremen for this work have, however, been trained, after much difficulty.

The suburban portions of the city, with the exception of the Vedado, have grown up along main roads. With respect to Jesus del Monte and Cerro this is especially true, and to an extent regrettable. Both of these suburban districts have expanded considerably and have quite a traffic of their own, in addition to the rural traffic, which of necessity uses the Calzadas of those respective names. Unfortunately, in this expansion, no provision has been made for parallel streets, and the necessity of relieving both the Calzada del Cerro and Calzada de Jesus del Monte of some portion of their traffic is urgent.

In connection with the work of construction of conceded but unbuilt lines, the Habana Electric Railway Company will be required to place at the disposal of the city of Habana a sum not to exceed \$25,000, to be applied in opening a street approximately parallel to the Calzada del Cerro, which will also furnish a new crossing of Matadero Creek, and in a large degree relieve the congestion at Cuatro Caminos and the Chavez bridge. Accompanying views of Concha, Fomento, Santa Rosa, and Romay streets show lines which might be followed in paralleling Calzada de Jesus del Monte. At the time when macadam construction was stopped, it was proposed to almost immediately commence work upon the construction of these streets, in order to relieve the Jesus del Monte congestion. Another much needed way is one to connect the southern portions of Jesus del Monte and Cerro.

STREET RAILWAYS.

At the time of the American occupation the only provision for rapid transit existing consisted of 6 miles of single track street railway and 7.5 miles of double track line. Tractive force was supplied by horses with exception of one line, which extended from a point near the harbor entrance in a westerly direction, and approximately parallel to the coast, as far as the Almendares River, passing through the suburbs of Vedado and Carmelo, and this was operated by dummy steam locomotives. The horse-car lines provided access from the northeastern part of the city to Principe Hill, Cerro, and Jesus del Monte. Such provision has been so slow and inadequate as to bring about an enormous use of cabs. The Ferrocarril Urbano, which owned the existing lines, had legal concessions for a number of unbuilt lines. Concessions known as the "Torre-Pla" had been formally granted for a competing line, but no construction had been undertaken. Early in the year 1899, both of these interests asked for authority to construct.

They were informed that authorization to build upon all the conceded lines would not be granted, and were requested to agree upon one general system, following as far as possible the conceded lines, which should serve as fully as practicable the necessities of the city for street-railway transportation, and at the same time occupy to the least possible extent the streets of the city. The representatives of the two interests of the department of public works (for the state), and of the ayuntamiento of the city, cooperated with the engineer department in the development of such a plan, the attainment of which was facilitated by the consolidation, during the latter part of 1899, of the rival interests, which are now represented by the Habana Electric Railway Company.

The lines granted in the two concessions are shown on plate 52. The "approved plan" is shown on plate 53. An examination of these plates shows that in the old and closely built portion of the city where the streets are narrowest, the number of lines is much less than was conceded, while the high and healthful unbuilt sections in the western and southwestern portions of the city will be made accessible and make possible the diffusion of the population over a reasonably large area.

The reconstruction of the old lines has begun. Grooved girder rails of the "Washington" type, weighing 90 pounds per lineal yard, held to gauge by steel ties, are laid upon a solid concrete bed which projects half a meter outside of the rails. The railway company paves between the rails and for half a meter on each side of the track, with vitrified brick or asphalt block (the paving material being specified by the department). Electric traction is to be employed. Because of the frequency of torrential rains, it was thought inadvisable to use the "conduit" system, and protection of the water mains and other underground pipes is secured by the requirement that the company shall employ the "double overhead trolley," which insulates the electric current from the earth. In the very narrow streets, the trolley poles will be placed against the sides of the houses and will project only 3 inches therefrom. All auxiliary feed wires will be carried in underground ducts of vitrified shale. One of the ducts is reserved for the use of the State, and one for the municipality. The cars are to be 8 feet wide, and will have a central aisle with a row of transverse seats on each side. The headway of the cars on the principal lines will be from two and one-half to five minutes. A complete system of transfers is provided for, which will permit passage from any part of the city to any other part for one fare.

DEPARTMENT OF STREET CLEANING AND PARKS.

[Mr. A. C. Harper, assistant engineer, in charge.]

Until December 31, 1899, this department was a branch of the department of streets, with street cleaning, street sprinkling, and parks, under the superintendence of Mr. Harper. Since January 1, 1900, it has been organized as a separate department. The organization of the work has been improved from time to time through the year, with marked results in economy and efficiency. As now

Office of
city

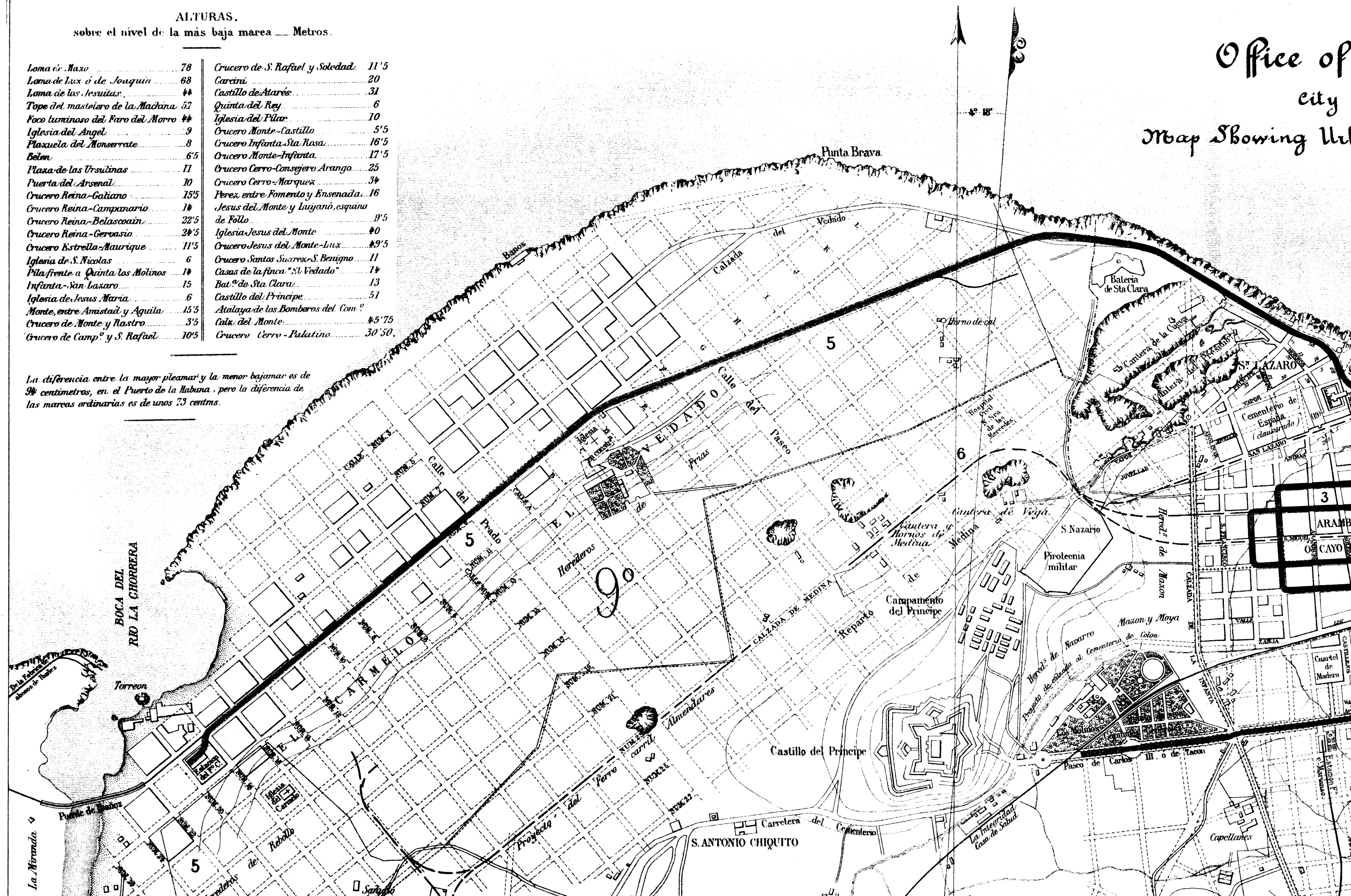
Map Showing Urb

ALTURAS.

sobre el nivel de la más baja marea — Metros.

| | | | |
|----------------------------------|------|--------------------------------------------|-------|
| Loma de Maxo | 78 | Crucero de S. Rafael y Soledad | 11'5 |
| Loma de Lux o de Souquin | 68 | Carcin | 20 |
| Loma de los Jesuitas | 44 | Castillo de Atarés | 31 |
| Tope del mastelero de la Máquina | 57 | Quinta del Rey | 6 |
| Foco luminoso del Faro del Morro | 44 | Iglesia del Pilar | 10 |
| Iglesia del Angel | 9 | Crucero Monte-Castillo | 5'5 |
| Plazuela del Monserrate | 8 | Crucero Infanta-Sa Rosa | 16'5 |
| Belén | 6'5 | Crucero Monte-Infanta | 17'5 |
| Plaza de las Ursulinas | 11 | Crucero Cerro-Consuegro Arango | 25 |
| Puerta del Arsenal | 10 | Crucero Cerro-Marquez | 34 |
| Crucero Reina-Galiano | 15'5 | Perez, entre Fomento y Ensenada | 16 |
| Crucero Reina-Campanario | 14 | Jesus del Monte y Lujano, esquina de Follo | 9'5 |
| Crucero Reina-Belascoain | 22'5 | Iglesia Jesus del Monte | 40 |
| Crucero Reina-Cervasio | 24'5 | Crucero Jesus del Monte-Lux | 49'5 |
| Crucero Estrella-Maurique | 11'5 | Crucero Santos Suarez-S. Benigno | 11 |
| Iglesia de S. Nicolas | 6 | Casas de la finca "El Vedado" | 14 |
| Pila frente a Quinta los Molinos | 14 | Bat. de Sta Clara | 13 |
| Infanta-San Lázaro | 15 | Castillo del Principe | 51 |
| Iglesia de Jesus Maria | 6 | Atalaya de los Bomberos del Com.º | 45'75 |
| Monte, entre Amistad y Aguila | 15'5 | Calle del Monte | 30'50 |
| Crucero de Monte y Rastro | 3'5 | | |
| Crucero de Camp.º y S. Rafael | 10'5 | | |

La diferencia entre la mayor pleamar y la menor bajamar es de 94 centímetros, en el Puerto de la Habana, pero la diferencia de las mareas ordinarias es de unos 73 centms.

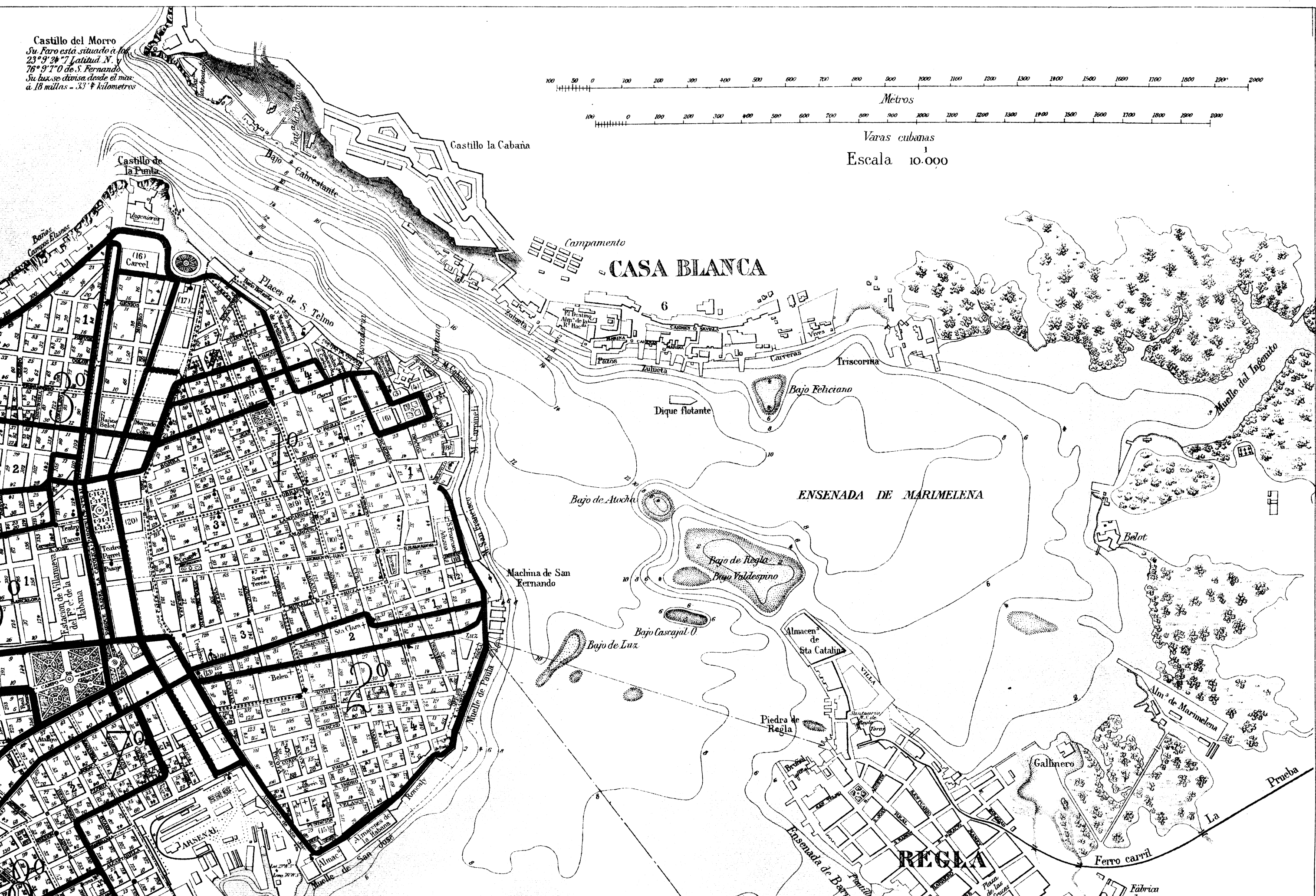


Office of Chief Engineer
City of Havana
Map Showing Urbano and Torre Pla Concession

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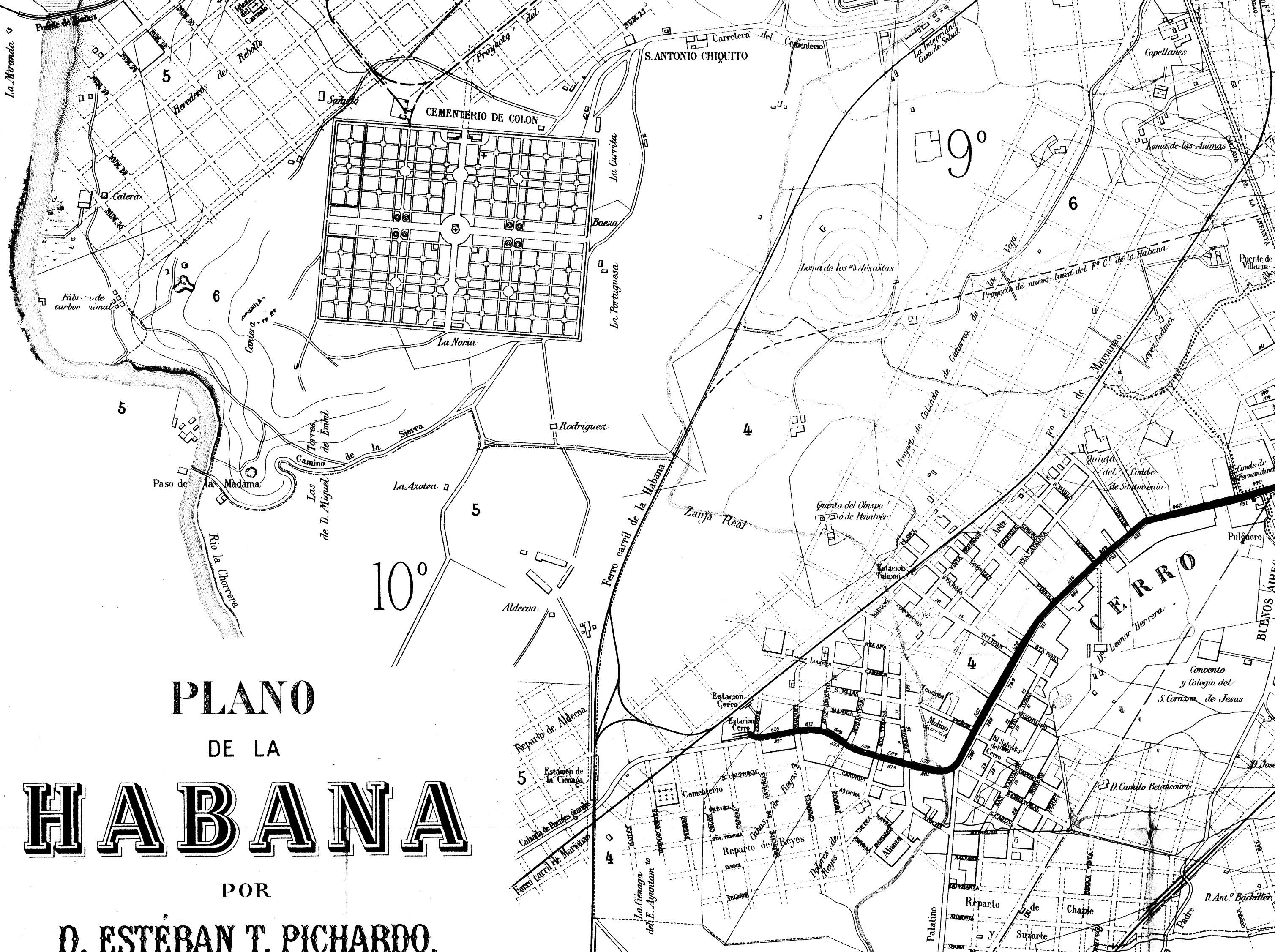
ion.

Castillo del Morro
Su Faro está situado a las
23° 9' 24" 7 Latitud N. y
76° 9' 17" 0 de S. Fernando
Su luz se divisa desde el mar
a 18 millas - 33 1/2 kilómetros



PLANO
DE LA
HABANA

POR
D. ESTEBAN T. PICHARDO.







PLANO DE LA HABANA

POR

D. ESTEBAN T. PICHARDO,

AGRIMENSOR Y MAESTRO DE OBRAS.

EDITOR: D. JOSÉ VALDEPARES.

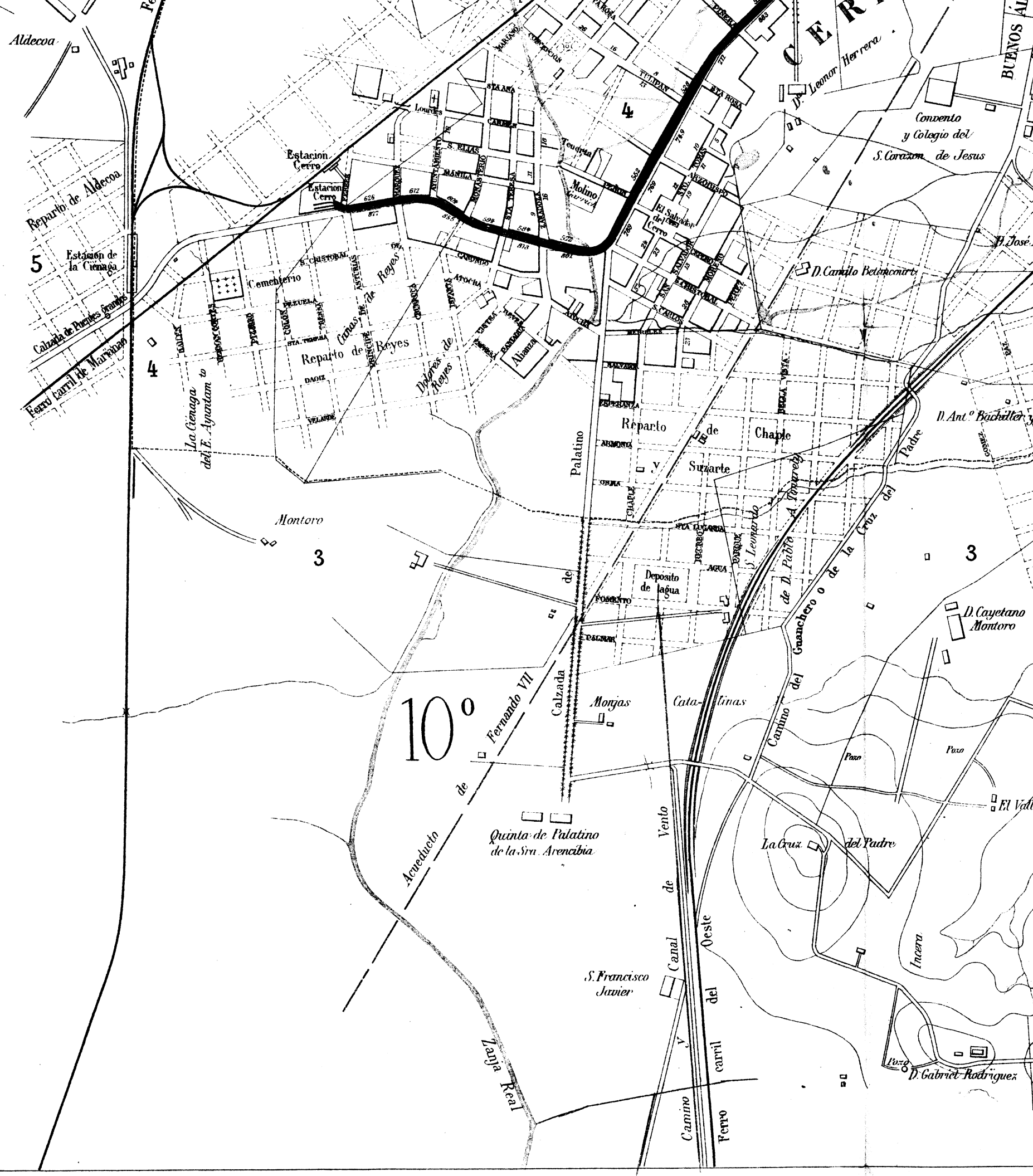
Para la formación de este Plano, se han tenido presentes: el publicado por el Excmo. Ayuntamiento, el del Puerto por los Ingenieros de Obras publicas y otros debidos a los Sres. D. Mariano Carles, D. José Ocampo, D. J. Manuel Alvaro, D. Alberto de Castro, D. Antonio Ariza, D. José Lopez Trigo, D. José C. del Castillo, D. Simon Teja &c; cuyos trabajos ha combinado el Autor del presente, añadiendo los que practicó expreso sobre el terreno.

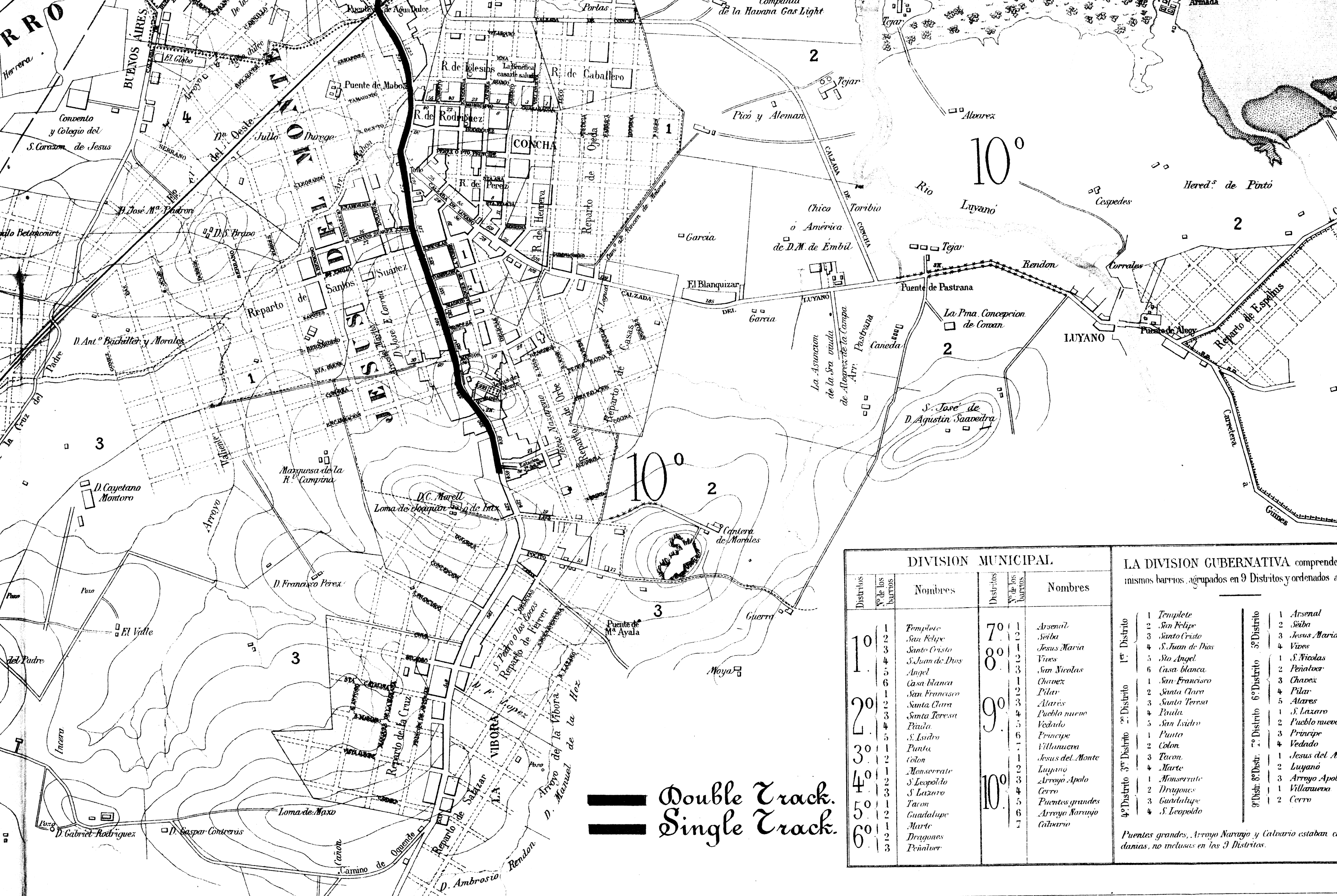
Las curvas de igual sonda, dibujadas en el Puerto, indican la profundidad del agua de dos en dos metros, en baja mar, y están deducidas del sondeo verificado por O. publicas en 1874.

- 5 Estac. telegráfica
- Caja de agua
- ◆ Caja y sifon
- Sifon
- Ferro carril en explotacion
- - - Idem en proyecto
- † Parroquia
- |-|-|-| Limite Municipal
- - - Idem de Distrito municipal
- - - Idem de Barrio
- ++++ Idem de Parroquia

Los números de las casas corresponden al último de cada frente de manzana y están escritos en carácter italico, como 1, 2, 3, &c.
Los que se refieren a la numeracion del Directorio, están escritos en carácter romanos, y entre paréntesis: (1) (2) (3) (4)
Los ordinales de las Distritos municipales son de carácter capitales y llevan grande: 1º

Los de los barrios son de carácter romano, mayores que los del Directorio: 1, 2, 3





Double Track.
Single Track.

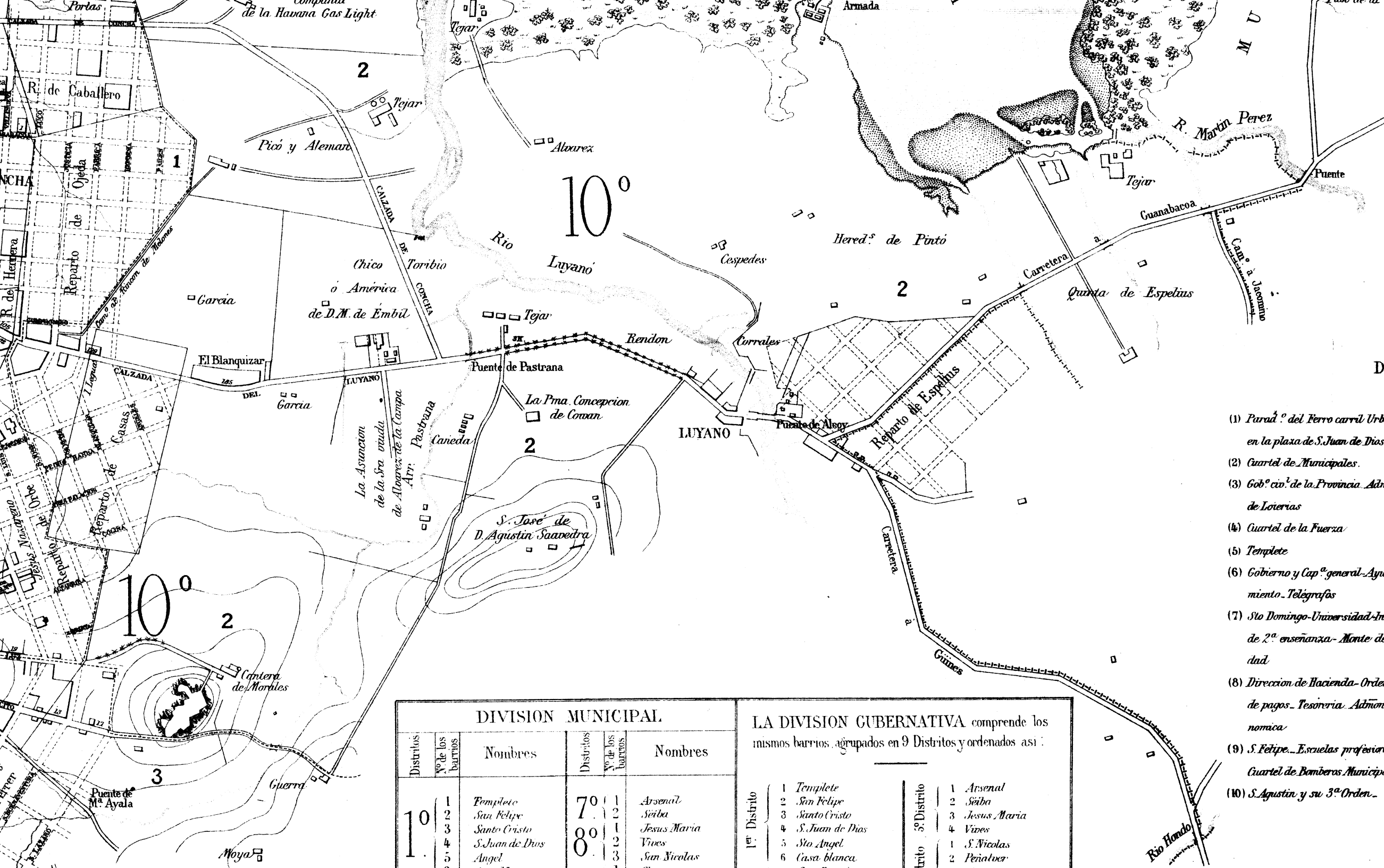
| DIVISION MUNICIPAL | | | | | | | |
|--------------------|-------------------|-----------------|--|-----------|-------------------|-----------------|--|
| Districts | Nº de los barrios | Nombres | | Districts | Nº de los barrios | Nombres | |
| 1º | 1 | Templeto | | 7º | 1 | Arsenal | |
| | 2 | San Felipe | | 8º | 2 | Seiba | |
| | 3 | Santo Cristo | | | 1 | Jesus Maria | |
| | 4 | S. Juan de Dios | | | 2 | Vines | |
| | 5 | Angel | | | 3 | San Nicolas | |
| | 6 | Casa Blanca | | | 1 | Chavez | |
| 2º | 1 | San Francisco | | | 2 | Pilar | |
| | 2 | Santa Clara | | | 3 | Altaviz | |
| | 3 | Santa Teresa | | | 4 | Pueblo nuevo | |
| | 4 | Paula | | | 5 | Vedado | |
| 3º | 1 | S. Isidro | | | 6 | Principe | |
| | 2 | Punta | | | 7 | Villanueva | |
| | 3 | Colon | | | 1 | Jesus del Monte | |
| 4º | 1 | Monserate | | | 2 | Lujano | |
| | 2 | S. Leopoldo | | | 3 | Arroyo Apolo | |
| | 3 | S. Lazaro | | | 4 | Cerro | |
| 5º | 1 | Tacon | | | 5 | Puentes grandes | |
| | 2 | Guadalupe | | | 6 | Arroyo Narvaño | |
| | 3 | Marte | | | 7 | Calvario | |
| 6º | 1 | Dragones | | | | | |
| | 2 | Peñalver | | | | | |

LA DIVISION GUBERNATIVA comprende los mismos barrios agrupados en 9 Distritos y ordenados así

| | | | | | |
|-------------|---|------------------------|-------------|---|------------------------|
| 1º Distrito | 1 | <i>Templeto</i> | 5º Distrito | 1 | <i>Arsenal</i> |
| | 2 | <i>San Felipe</i> | | 2 | <i>Seiba</i> |
| | 3 | <i>Santo Cristo</i> | | 3 | <i>Jesus Maria</i> |
| | 4 | <i>S. Juan de Dios</i> | | 4 | <i>Vives</i> |
| | 5 | <i>St. Angel</i> | | 1 | <i>S. Nicolas</i> |
| | 6 | <i>Casa blanca</i> | | 2 | <i>Peñalver</i> |
| 2º Distrito | 1 | <i>San Francisco</i> | 6º Distrito | 3 | <i>Chavez</i> |
| | 2 | <i>Santa Clara</i> | | 4 | <i>Pilar</i> |
| | 3 | <i>Santa Teresa</i> | | 5 | <i>Altaviz</i> |
| | 4 | <i>Paula</i> | | 1 | <i>S. Lazaro</i> |
| | 5 | <i>San Isidro</i> | | 2 | <i>Pueblo nuevo</i> |
| 3º Distrito | 1 | <i>Punta</i> | 7º Distrito | 3 | <i>Principe</i> |
| | 2 | <i>Colon</i> | | 4 | <i>Vedado</i> |
| | 3 | <i>Tacon</i> | | 1 | <i>Jesus del Monte</i> |
| | 4 | <i>Marte</i> | | 2 | <i>Lujanó</i> |
| 4º Distrito | 1 | <i>Monserate</i> | 8º Distr. | 3 | <i>Arroyo Apolo</i> |
| | 2 | <i>Dragones</i> | | 1 | <i>Villanueva</i> |
| | 3 | <i>Guadalupe</i> | 9º Distrito | 2 | <i>Cerro</i> |
| | 4 | <i>S. Leopoldo</i> | | | |

Puentes grandes, Arroyo Navarro y Calvario estaban en las 3 distritas.

Puentes grandes, Arroyo Narvaño y Calvario estaban en las 9 distancias, no incluidas en los 9 Distritos.



Double Track.
Single Track.

| DIVISION MUNICIPAL | | | | | LA DIVISION GUBERNATIVA comprende los mismos barrios agrupados en 9 Distritos y ordenados asi : | | | | |
|--------------------|-------------------|-----------------|-----------|-------------------|-------------------------------------------------------------------------------------------------|-------------|-------------------|-----------------|-------------|
| Distritos | Nº de los barrios | Nombres | Distritos | Nº de los barrios | Nombres | Distritos | Nº de los barrios | Nombres | Distritos |
| 1º | 1 | Templete | 7º | 1 | Arsenal | 1º Distrito | 1 | Templete | 5º Distrito |
| | 2 | San Felipe | | 2 | Siiba | | 2 | San Felipe | |
| | 3 | Santo Cristo | | 3 | Jesus Maria | | 3 | Santo Cristo | |
| | 4 | S. Juan de Dios | 8º | 1 | Vinos | | 4 | S. Juan de Dios | |
| | 5 | Angel | | 2 | San Nicolas | | 5 | Sto Angel | |
| | 6 | Casa blanca | | 3 | Chavez | | 6 | Casa blanca | |
| 2º | 1 | San Francisco | 9º | 1 | Pilar | 2º Distrito | 1 | San Francisco | 6º Distrito |
| | 2 | Santa Clara | | 2 | Alarés | | 2 | Santa Clara | |
| | 3 | Santa Teresa | | 3 | Pueblo nuevo | | 3 | Santa Teresa | |
| | 4 | Piñata | | 4 | Vedado | | 4 | Paula | |
| 3º | 1 | S. Isidro | 10º | 5 | Principe | 3º Distrito | 5 | San Isidro | 7º Distrito |
| | 2 | Punta | | 6 | Villanueva | | 1 | Punto | |
| 4º | 1 | Colon | | 1 | Jesus del Monte | | 2 | Colon | |
| | 2 | Monserate | | 2 | Luyano | | 3 | Tacon | |
| 5º | 1 | S. Leopoldo | | 3 | Arroyo Apolo | | 4 | Marte | |
| | 2 | S. Lázaro | | 4 | Puentes grandes | 4º Distrito | 1 | Monserate | |
| 6º | 1 | Tacon | | 5 | Arroyo Navajo | | 2 | Dragones | |
| | 2 | Guadalupe | | 6 | Calvario | | 3 | Guadalupe | |
| | 3 | Marte | | | | | 4 | S. Leopoldo | |
| | 1 | Dragones | | | | | | | |
| | 2 | Penalver | | | | | | | |
| | 3 | | | | | | | | |

Puentes grandes, Arroyo Navajo y Calvario estaban como Pe-
danas, no incluidas en los 9 Distritos.

DIRECTORIO

- | | |
|--------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| (1) Parada 1º del Ferro carril Urbano, en la plaza de S. Juan de Dios | Academia de ciencias medicas, fisicas y naturales. |
| (2) Cuartel de Municipales. | (11) Admon. de Correos - Intervencion de Marina. Deposito hidrogra- fico |
| (3) Gob. civ. de la Provincia. Adminis. de Licerias | (12) Comand. 1º gral del Apostadero |
| (4) Cuartel de la Fuerza | (13) Cuartelillo Bomb. municipales |
| (5) Tempete | (14) Cuartel Bomb. del Comercio |
| (6) Gobierno y Cap. general. Ayunta- miento. Telégrafos | (15) Casa de Recogidas, de S. Juan Jepomuceno |
| (7) Sto Domingo-Universidad-Instituto de 2ª enseñanza - Monte de pio- dad | (16) Carcel. Presidio Hospital civil de S. Felipe y Santiago |
| (8) Direccion de Hacienda-Orden 1º de pagos - Tesoreria. Admon. Eco- nomica | (17) Morgue o Necrasomio Obras municipales |
| (9) S. Felipe. Escuelas profesionales. Cuartel de Bomberos Municipales | (18) Asilo de S. Jose, de Artes y Oficios |
| (10) S. Agustin y su 3º Orden. | (19) Teatro de Albizu, o de Lersundi Casino español |
| | (20) Cuartel de la Guardia civil |

Office of Chief Engineer
Division of Cuba.

To accompany Report of June 30th, 1900.

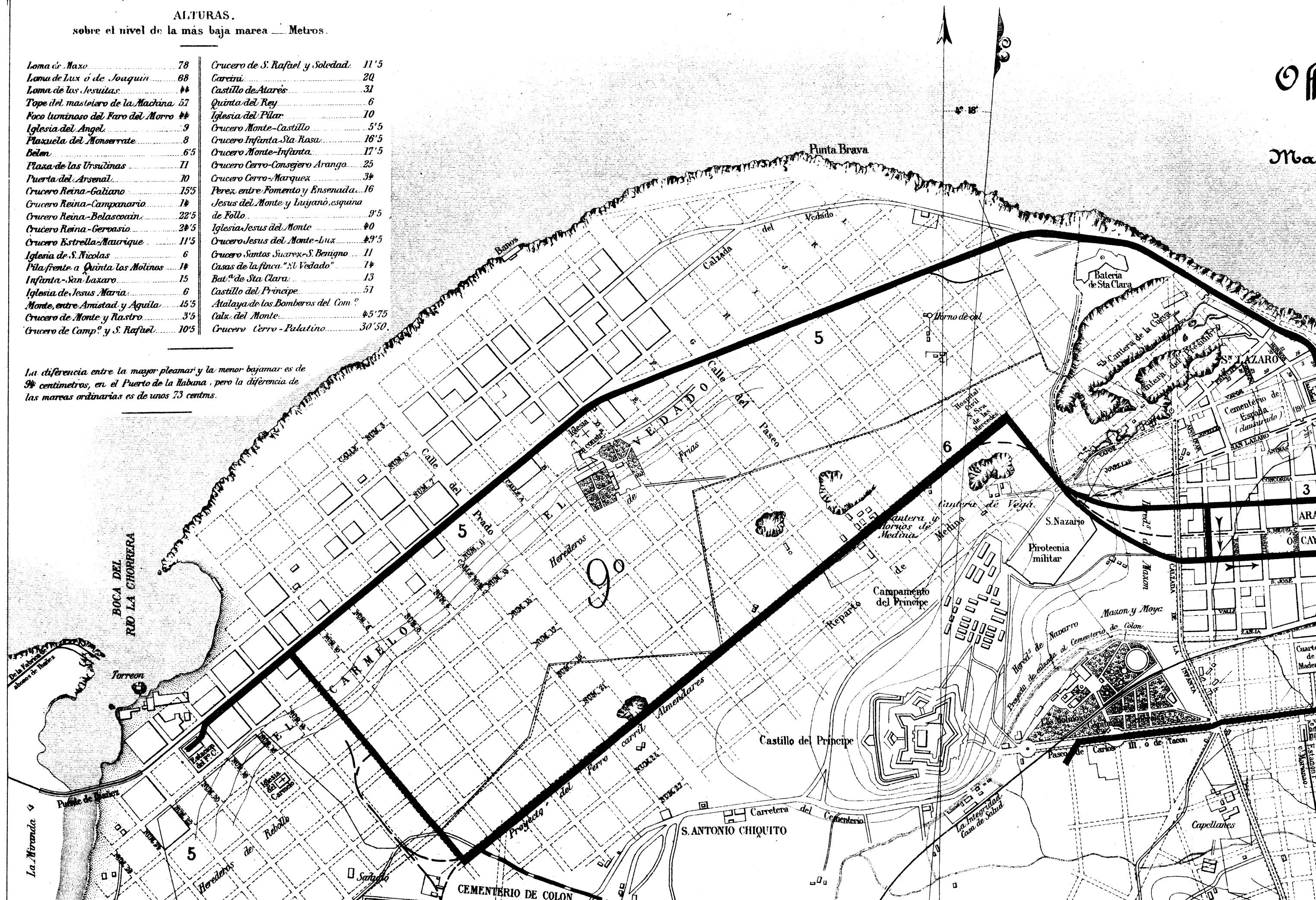
W. M. Rush

Major Corps of Engineers, U.S.A.
Chief Engineer Division of Cuba.

ALTURAS.
sobre el nivel de la más baja marea — Metros.

| | | | |
|----------------------------------|------|--------------------------------------------|-------|
| Loma de Maxo | 78 | Crucero de S. Rafael y Soledad | 11'5 |
| Loma de Lux ó de Souquin | 68 | Carcin | 20 |
| Loma de los Jesuitas | 44 | Castillo de Atarés | 31 |
| Tope del mastelero de la Machina | 57 | Quinta del Rey | 6 |
| Foco luminoso del Faro del Morro | 44 | Iglesia del Pilar | 10 |
| Iglesia del Angel | 9 | Crucero Monte-Castillo | 5'5 |
| Plaxuela del Monserrate | 8 | Crucero Infanta Sta Rosa | 16'5 |
| Belén | 6'5 | Crucero Monte-Infanta | 17'5 |
| Plaza de las Ursulinas | 11 | Crucero Cerro-Consejero Arango | 25 |
| Puerta del Arsenal | 10 | Crucero Cerro-Marquez | 34 |
| Crucero Reina-Galiano | 15'5 | Perez entre Fomento y Ensenada | 16 |
| Crucero Reina-Campanario | 14 | Jesus del Monte y Lujano, esquina de Follo | 9'5 |
| Crucero Reina-Belascosain | 22'5 | Iglesia Jesus del Monte | 40 |
| Crucero Reina-Gervasio | 24'5 | Crucero Jesus del Monte-Lux | 49'5 |
| Crucero Estrella-Maurique | 11'5 | Crucero Santos Suarez-S. Benigno | 11 |
| Iglesia de S. Nicolas | 6 | Casas de la finca "El Vedado" | 14 |
| Pila frente a Quinta los Molinos | 14 | Bat.ª de Sta Clara | 13 |
| Infanta-San Lazaro | 15 | Castillo del Principe | 51 |
| Iglesia de Jesus Maria | 6 | Atalaya de los Bomberos del Com.º | |
| Monte, entre Amistad y Aguila | 15'5 | Calk. del Monte | 45'75 |
| Crucero de Monte y Rastro | 3'5 | Crucero Cerro-Palatino | 30'50 |
| Crucero de Camp.º y S. Rafael | 10'5 | | |

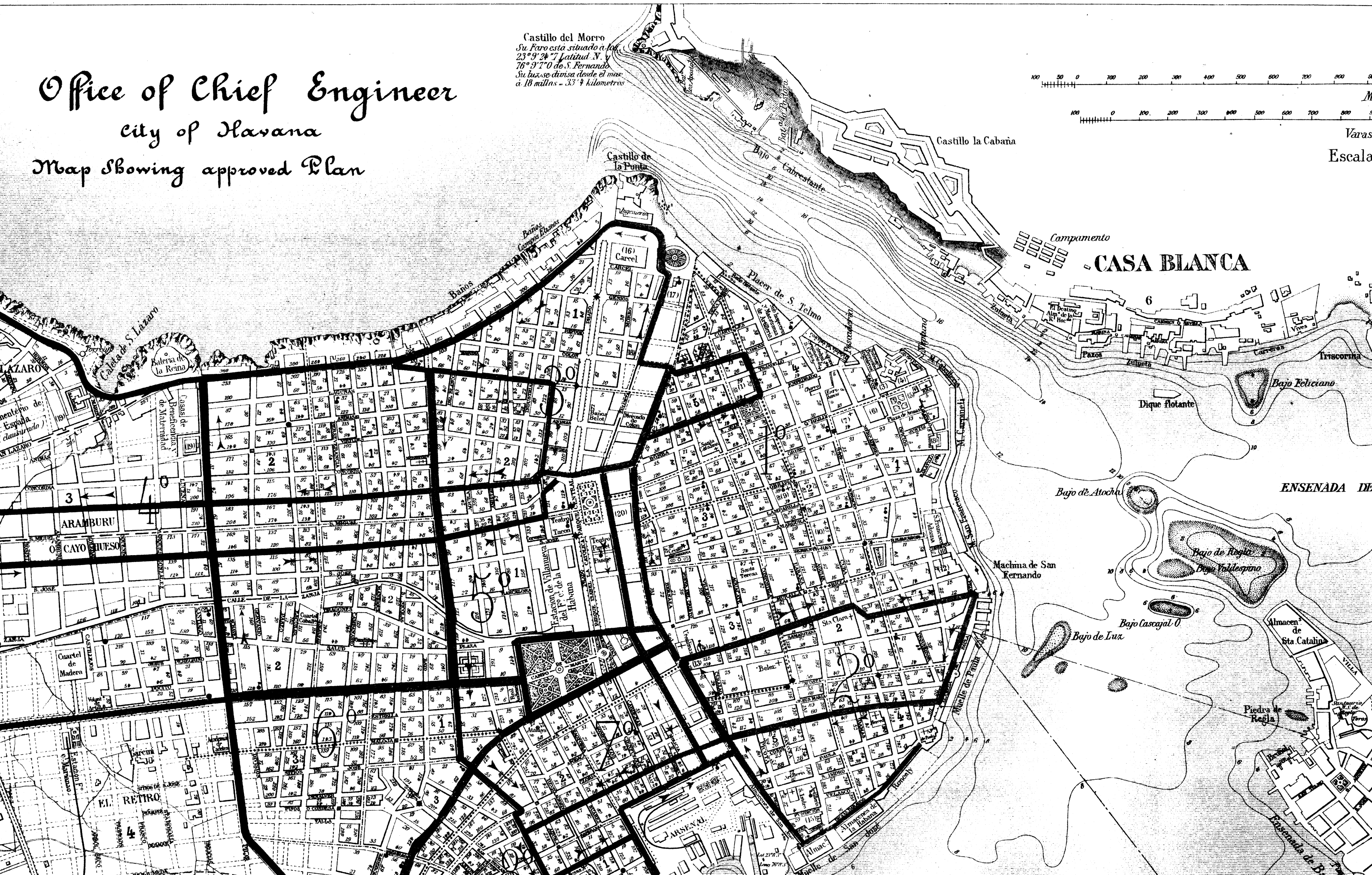
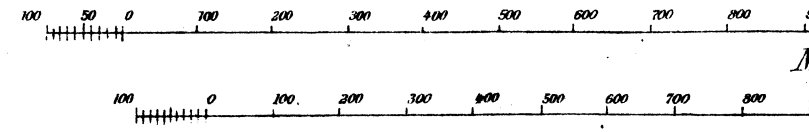
La diferencia entre la mayor pleamar y la menor bajamar es de 94 centímetros, en el Puerto de la Habana, pero la diferencia de las mareas ordinarias es de unos 73 centms.



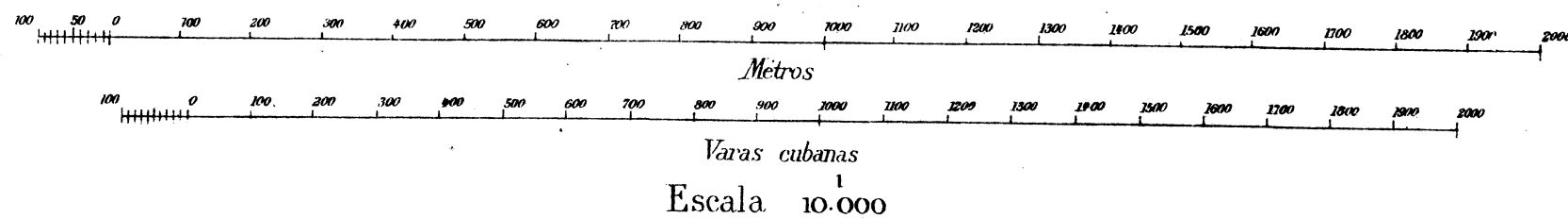
Approved Plan.

Office of Chief Engineer
City of Havana
Map Showing approved Plan

Castillo del Morro
Su Faro está situado a las
23° 9' 24" 7 Latitud N.
76° 9' 7" 0 de S. Fernando
Su luz se divisa desde el mar
a 18 millas = 33 1/2 kilometros



Castillo del Morro
 Su Faro está situado a los
 33° 9' 24" 7 Latitud N. y
 16° 9' 17" 0 de S. Fernando
 Su luz se divisa desde el mar
 18 millas = 33 1/2 kilometros







PLANO DE LA HABANA

POR
D. ESTEBAN T. PICHARDO,

AGRIMENSOR Y MAESTRO DE OBRAS.

EDITOR: D. JOSÉ VALDEPARES.

Para la formación de este Plano, se han tenido presentes: el publicado por el Excmo. Ayuntamiento, el del Puerto por los Ingenieros de Obras públicas, y otros debidos a los Sres. D. Mariano Carles, D. José Ocampo, D. J. Manuel Alvaro, D. Alberto de Castro, D. Antonio Ariza, D. José Lopez Trigo, D. José C. del Castillo, D. Simon Teja & ; cuyos trabajos ha combinado el Autor del presente, añadiendo los que practicó expreso sobre el terreno.

Las curvas de igual sonda, dibujadas en el Puerto, indican la profundidad del agua de dos en dos metros, en baja mar, y están deducidas del sondeo verificado por O. públicas en 1874.

- Estac. telegráfica
- Caja de agua
- Caja y sifón
- Sifón
- Ferrocarril en explotación
- Idem en proyecto
- Parroquia
- Limite Municipal
- Idem de Distrito municipal
- Idem de Barrio
- Idem de Parroquia

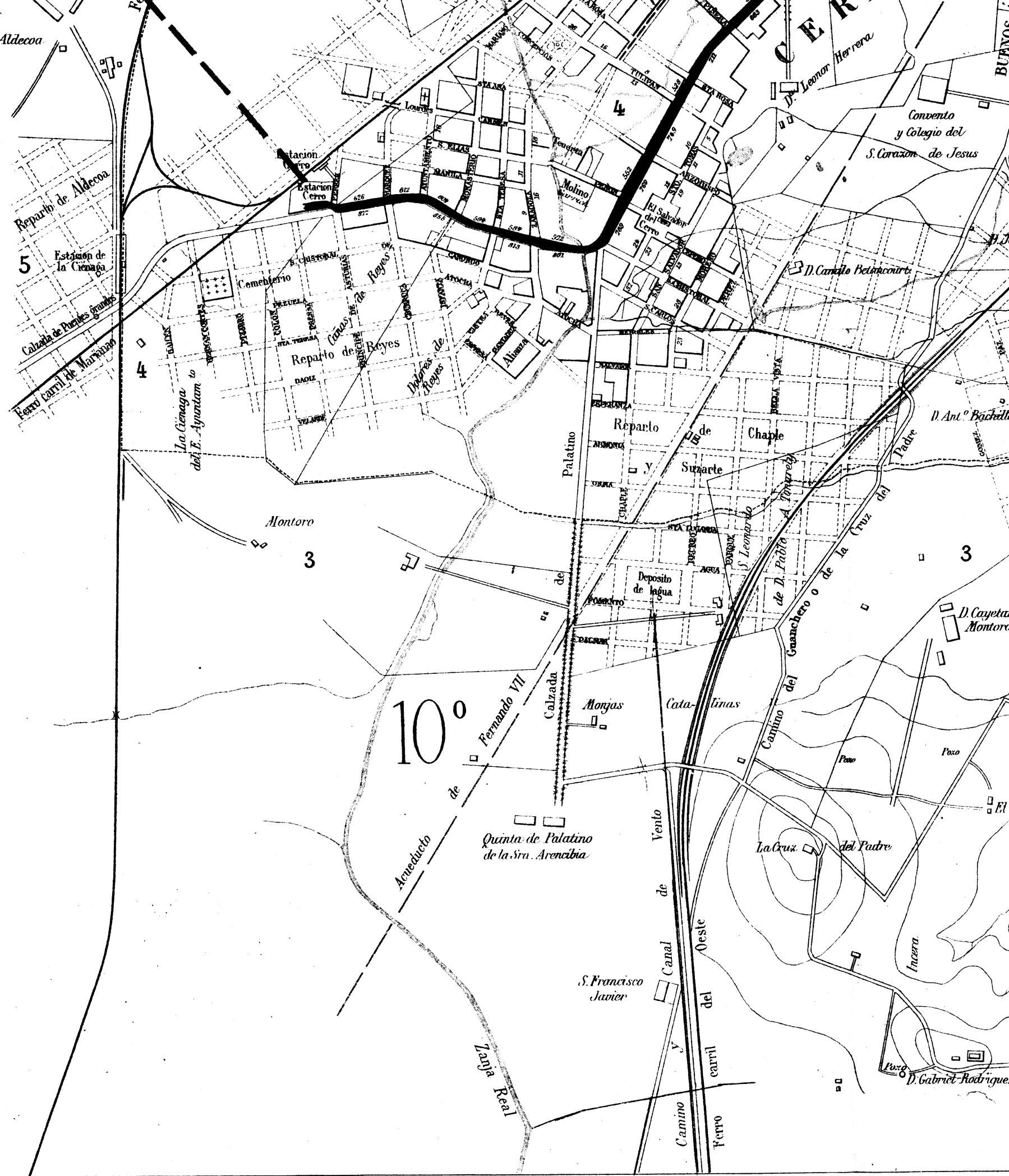
Servicio
de Bomberos

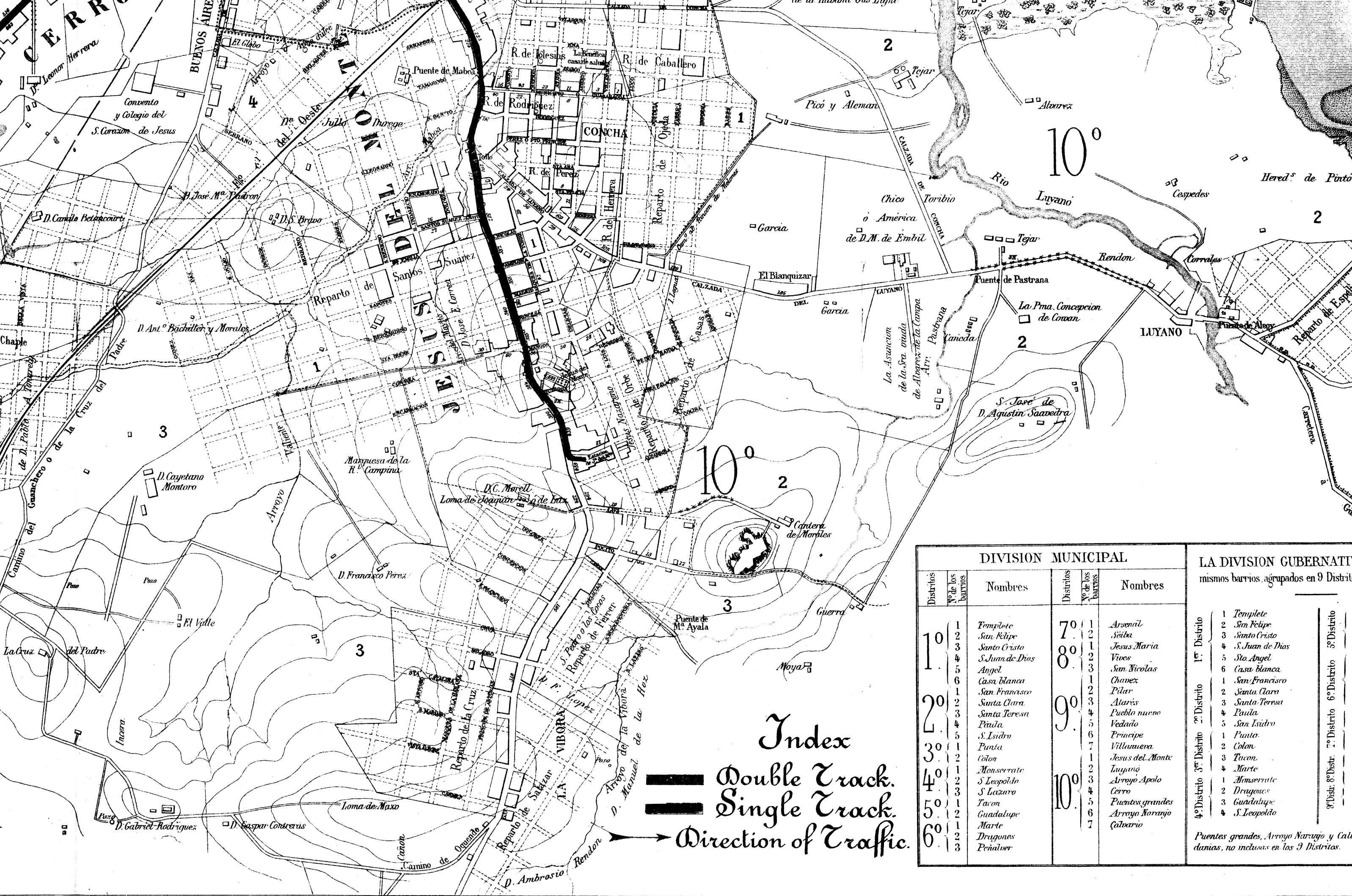
Los números de las casas corresponden al último de cada frente de manzana y están escritos en carácter *italico*, como 1, 2, 3, 4.

Los que se refieren a la numeración del Directorio, están escritos en carácter *romanos*, y entre *paréntesis*: (1) (2) (3) (4).

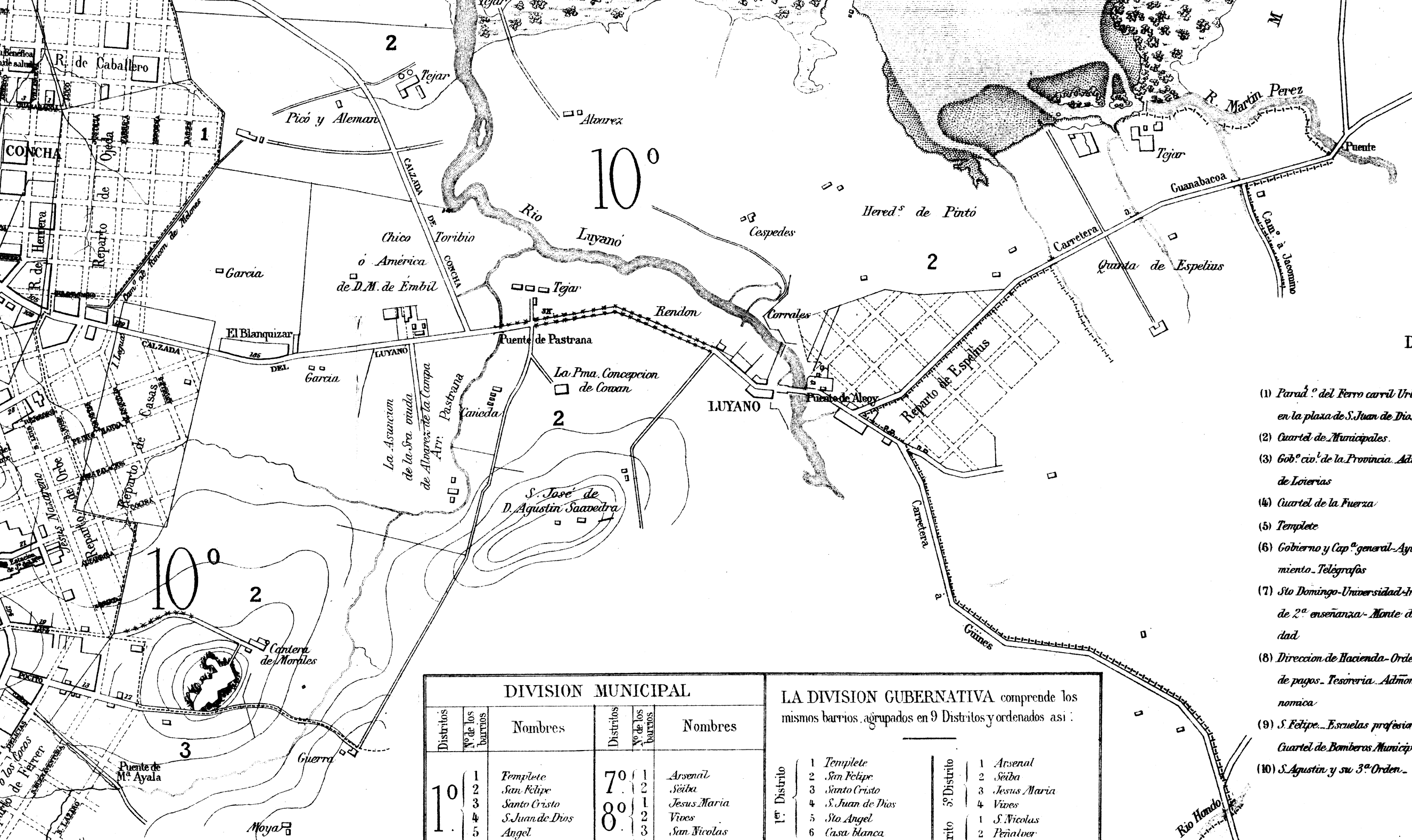
Los ordinales de los Distritos municipales son de carácter *capitales* y tamaño grande: 1º.

Los de los barrios son de carácter *romano*, mayores que los del Directorio: 1, 2, 3.





| DIVISION MUNICIPAL | | | | LA DIVISION GUBERNATIVA | | | |
|-----------------------------------------|-------------------|-----------------|-----------|-------------------------|-----------------|-------------|-------------------|
| mismos barrios agrupados en 9 Distritos | | | | | | | |
| Distritos | Nº de los barrios | Nombres | Distritos | Nº de los barrios | Nombres | Distritos | Nº de los barrios |
| 1º | 1 | Templete | 7º | 1 | Arsenal | 1º Distrito | 1 |
| | 2 | San Felipe | | 2 | Santa | | 2 |
| | 3 | Santo Cristo | | 3 | Jesus Maria | | 3 |
| | 4 | S. Juan de Dios | | 4 | Vicos | | 4 |
| | 5 | Angel | | 5 | San Nicolas | | 5 |
| | 6 | Casa blanca | | 6 | Chavez | | 6 |
| 2º | 1 | San Francisco | 8º | 1 | Pilar | 2º Distrito | 1 |
| | 2 | Santa Clara | | 2 | Alarés | | 2 |
| | 3 | Santa Teresa | | 3 | Pueblo nuevo | | 3 |
| | 4 | Paula | | 4 | Vedado | | 4 |
| | 5 | S. Isidro | | 5 | Principe | | 5 |
| 3º | 1 | Colon | 9º | 6 | Villavieja | 3º Distrito | 1 |
| | 2 | Monserate | | 7 | Jesus del Monte | | 2 |
| | 3 | S. Leopoldo | | 8 | Luyano | | 3 |
| 4º | 1 | S. Lazaro | 10º | 9 | Arroyo Apolo | 4º Distrito | 4 |
| | 2 | Tacon | | 10 | Puentes grandes | | 5 |
| 5º | 1 | Guadalupe | | | Arroyo Naranjo | 5º Distrito | 6 |
| | 2 | Marte | | | Calvario | | 7 |
| | 3 | Dragones | | | | | 8 |
| 6º | 1 | Peñalver | | | | | 9 |
| | 2 | | | | | | 10 |
| | 3 | | | | | | 11 |



DIRECTORIO

- (1) Parada^a del Ferro carril Urbano, en la plaza de S. Juan de Dios
- (2) Cuartel de Municipales.
- (3) Gob.^o cio.^l de la Provincia. Adminis.^a de Loerías
- (4) Cuartel de la Fuerza
- (5) Templete
- (6) Gobierno y Cap.^a general-Ayuntamiento- Telégrafos
- (7) Sto Domingo-Universidad-Instituto de 2.^a enseñanza- Monte de piedad
- (8) Direccion de Hacienda- Orden.^a de pagos- Tesoreria. Admon. Económica
- (9) S. Felipe- Escuelas profesionales- Cuartel de Bomberos Municipales
- (10) S. Agustin y su 3.^a Orden.
- Academia de ciencias medicas, fisicas y naturales.
- (11) Admon. de Correos- Intervencion de Marina- Deposito hidrográfico
- (12) Comand.^a gral del Apostadero
- (13) Cuartelillo Bomb.^o municipales
- (14) Cuartel Bomb.^o del Comercio
- (15) Casa de Recogidas, de S. Juan Nepomuceno
- (16) Carcel- Presidio Hospital civil de S. Felipe y Santiago
- (17) Morgue o Necroscopio Obras municipales
- (19) Asilo de S. Jose, de Artes y Oficios
- (20) Teatro de Albizu, o de Lorrundi
- (21) Cuartel de la Guardia civil

| DIVISION MUNICIPAL | | | | |
|--------------------|-------------------|-----------------|----------------|-------------------|
| Distritos | Nº de los barrios | Nombres | Distritos | Nº de los barrios |
| 1 ^o | 1 | Templete | 7 ^o | 1 |
| | 2 | San Felipe | | 2 |
| | 3 | Santo Cristo | 8 ^o | 1 |
| | 4 | S. Juan de Dios | | 2 |
| | 5 | Angel | | 3 |
| | 6 | Casa blanca | | 3 |
| 2 ^o | 1 | San Francisco | | 3 |
| | 2 | Santa Clara | 9 ^o | 1 |
| | 3 | Santa Teresa | | 2 |
| | 4 | Paula | | 4 |
| | 5 | S. Isidro | | 5 |
| 3 ^o | 1 | Punta | | 6 |
| | 2 | Colon | | 7 |
| 4 ^o | 1 | Monserate | | 1 |
| | 2 | S. Leopoldo | | 2 |
| | 3 | S. Lazaro | | 3 |
| 5 ^o | 1 | Tacon | | 4 |
| | 2 | Guadalupe | | 5 |
| 6 ^o | 1 | Marte | | 6 |
| | 2 | Dragones | | 7 |
| | 3 | Penalver | | |

| LA DIVISION GUBERNATIVA comprende los mismos barrios, agrupados en 9 Distritos y ordenados asi : | | | | |
|--------------------------------------------------------------------------------------------------|-------------------------|--------------------------|-------------------------|-------------------------|
| 1 ^{er} Distrito | 2 ^o Distrito | 3 ^{er} Distrito | 4 ^o Distrito | 5 ^o Distrito |
| 1 Templete | 1 San Felipe | 1 Santo Cristo | 1 S. Juan de Dios | 1 Sto Angel |
| 2 San Felipe | 2 Santa Clara | 2 Santa Teresa | 2 Paula | 2 San Isidro |
| 3 Santo Cristo | 3 Santa Clara | 3 Santa Teresa | 3 Punta | 3 Colon |
| 4 S. Juan de Dios | 4 Pilar | 4 Monserate | 4 Marte | 4 Tacón |
| 5 Sto Angel | 5 Alarés | 5 Villanueva | 5 San Lazaro | 5 Arroyo Apolo |
| 6 Casa blanca | 6 Pueblo nuevo | 6 Jesus del Monte | 6 Puentes grandes | 6 Villanueva |
| 7 San Francisco | 7 Vedado | 7 Principe | 7 Arroyo Naranjo | 7 Cerro |
| 8 Chavez | 8 Príncipe | 8 Villanueva | 8 Calvario | |
| 9 Pilar | 9 Vedado | | | |

Puentes grandes, Arroyo Naranjo y Calvario estaban como Peñonías, no incluidas en los 9 Distritos.

Puentes grandes, Arroyo Naranjo y Calvario estaban como Pedanías, no incluidas en los 9 Distritos.

Office of Chief Engineer
Division of Cuba.

To accompany Report of June 30th. 1900.

M. M. Black

Major Corps of Engineers. U.S.A.
Chief Engineer Division of Cuba.

Index

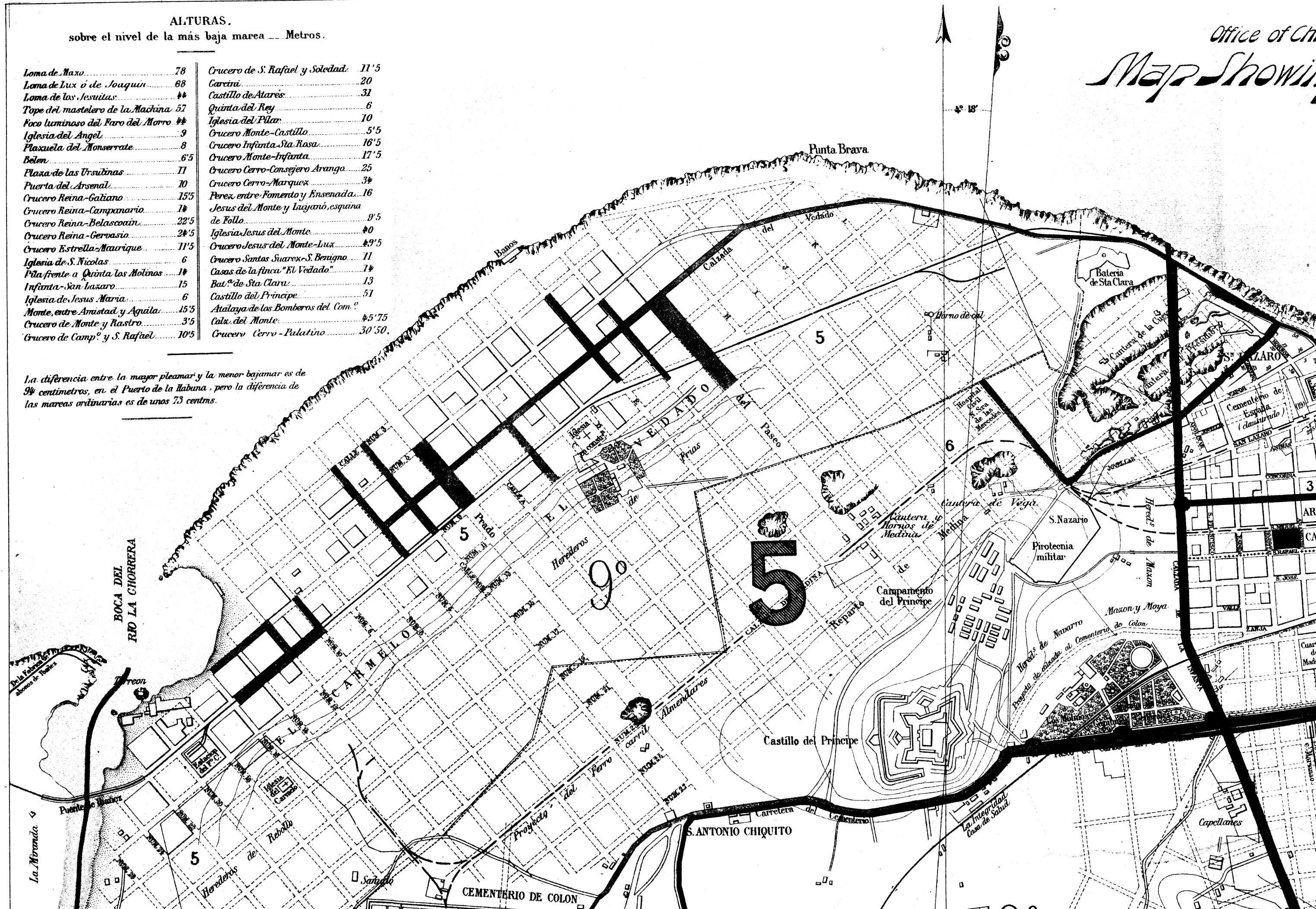
- Double Track.
- Single Track.
- Direction of Traffic.

ALTURAS.
sobre el nivel de la más baja marea — Metros.

| | | | |
|---------------------------------------|------|---------------------------------------|-------|
| Loma de Moxo..... | 78 | Crucero de S. Rafael y Soledad..... | 11'5 |
| Loma de Lux ó de Souquin..... | 68 | Carcini..... | 20 |
| Loma de los Jesuitas..... | 44 | Castillo de Alarés..... | 31 |
| Tope del mastelero de la Machina..... | 57 | Quinta del Rey..... | 6 |
| Foco luminoso del Faro del Morro..... | 44 | Iglesia del Pilar..... | 10 |
| Iglesia del Angel..... | 9 | Crucero Monte-Castillo..... | 5'5 |
| Plaxuela del Monserrate..... | 8 | Crucero Infanta Sta. Rosa..... | 16'5 |
| Belen..... | 6'5 | Crucero Monte-Infanta..... | 17'5 |
| Plaza de las Ursulinas..... | 11 | Crucero Cerro-Consuegro Arango..... | 25 |
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| Crucero Reina-Galiano..... | 15'5 | Perez entre Fomento y Ensenada..... | 16 |
| Crucero Reina-Campanario..... | 14 | Jesus del Monte y Luayano, esquina | |
| Crucero Reina-Belascoain..... | 22'5 | de Follo..... | 9'5 |
| Crucero Reina-Gervasio..... | 24'5 | Iglesia Jesus del Monte..... | 40 |
| Crucero Estrella-Maurique..... | 11'5 | Crucero Jesus del Monte-Lux..... | 49'5 |
| Iglesia de S. Nicolas..... | 6 | Crucero Santos Suarez-S. Benigno..... | 11 |
| Pila frente a Quinta los Molinos..... | 14 | Casas de la finca "El Vedado"..... | 14 |
| Infanta-San Lázaro..... | 15 | Bat.ª de Sta Clara..... | 13 |
| Iglesia de Jesus Maria..... | 6 | Castillo del Principe..... | 51 |
| Monte, entre Amistad y Aguila..... | 15'5 | Atalaya de los Bomberos del Com.º | |
| Crucero de Monte y Rastro..... | 3'5 | Calx. del Monte..... | 45'75 |
| Crucero de Camp.º y S. Rafael..... | 10'5 | Crucero Cerro-Palatino..... | 30'50 |

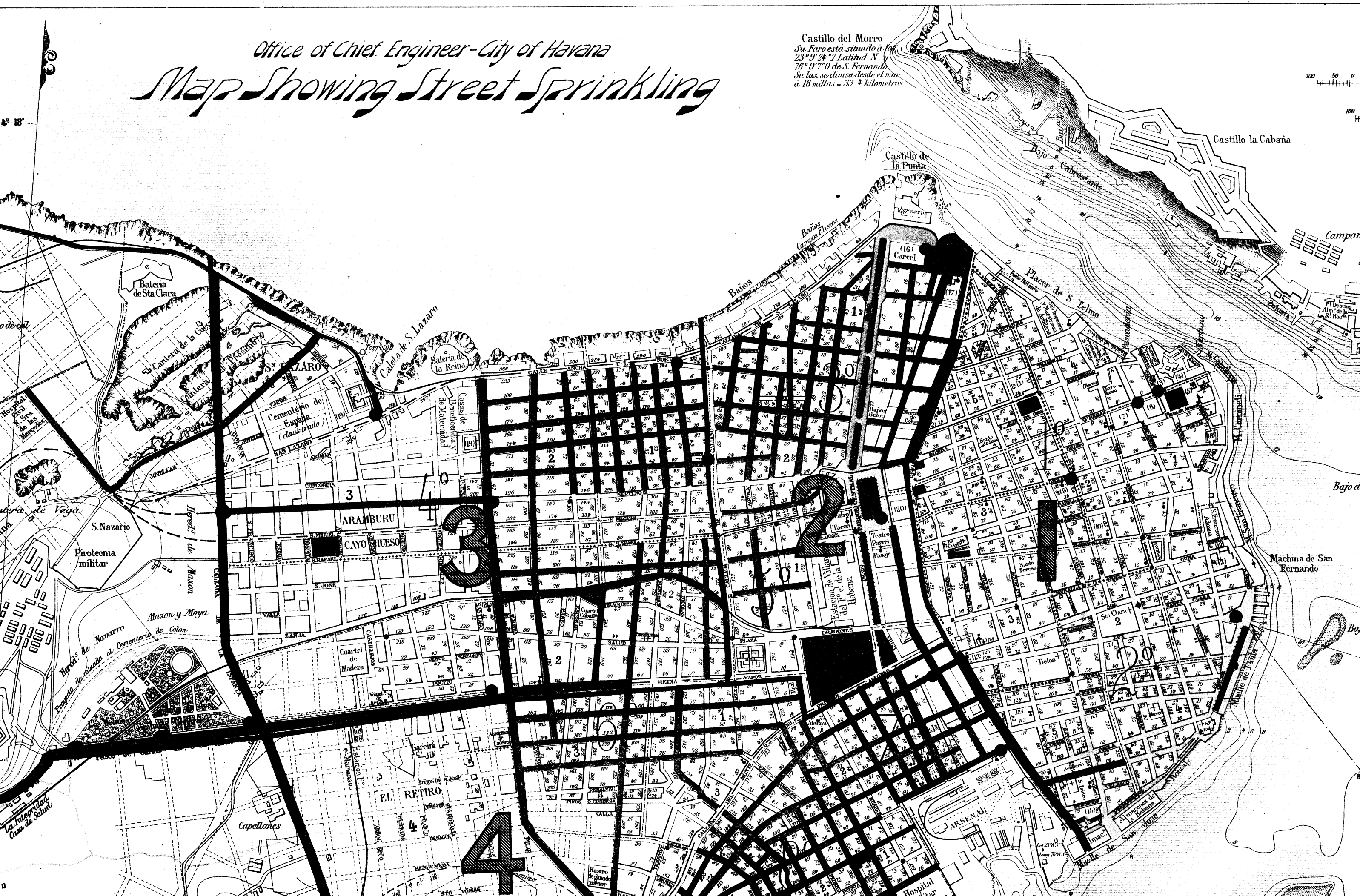
La diferencia entre la mayor pleamar y la menor bajamar es de 94 centímetros, en el Puerto de la Habana, pero la diferencia de las mareas ordinarias es de unos 73 centms.

Office of Charts
Map Showing

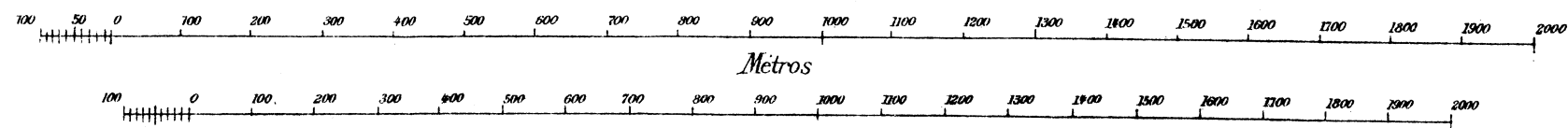


Office of Chief Engineer-City of Havana
Map Showing Street Sprinkling

Castillo del Morro
Su Faro está situado a las
23° 9' 24" Latitud N.
76° 9' 7" O de S. Fernando.
Su luz se divide desde el mar
a 13 millas = 33 1/2 kilometros

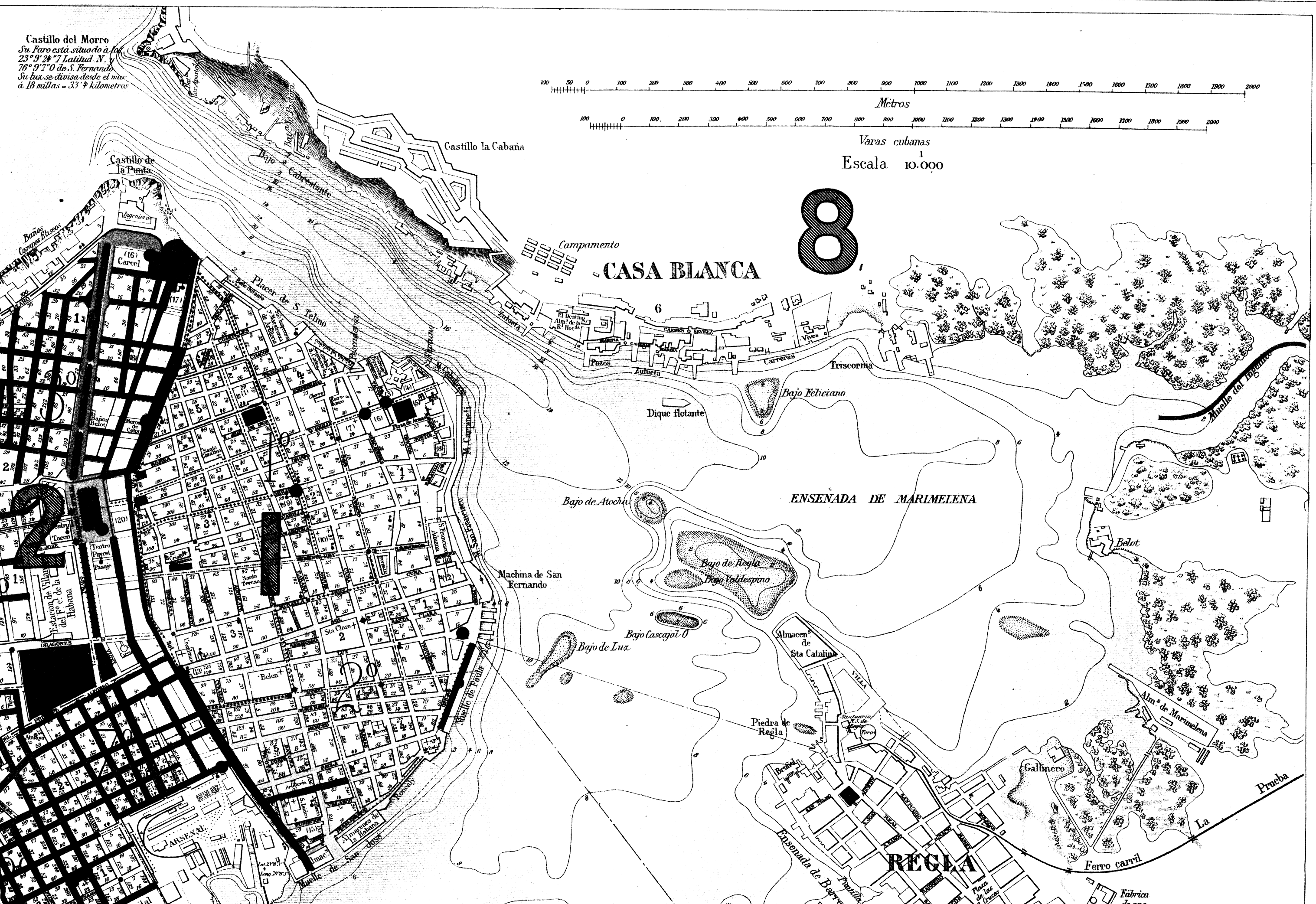


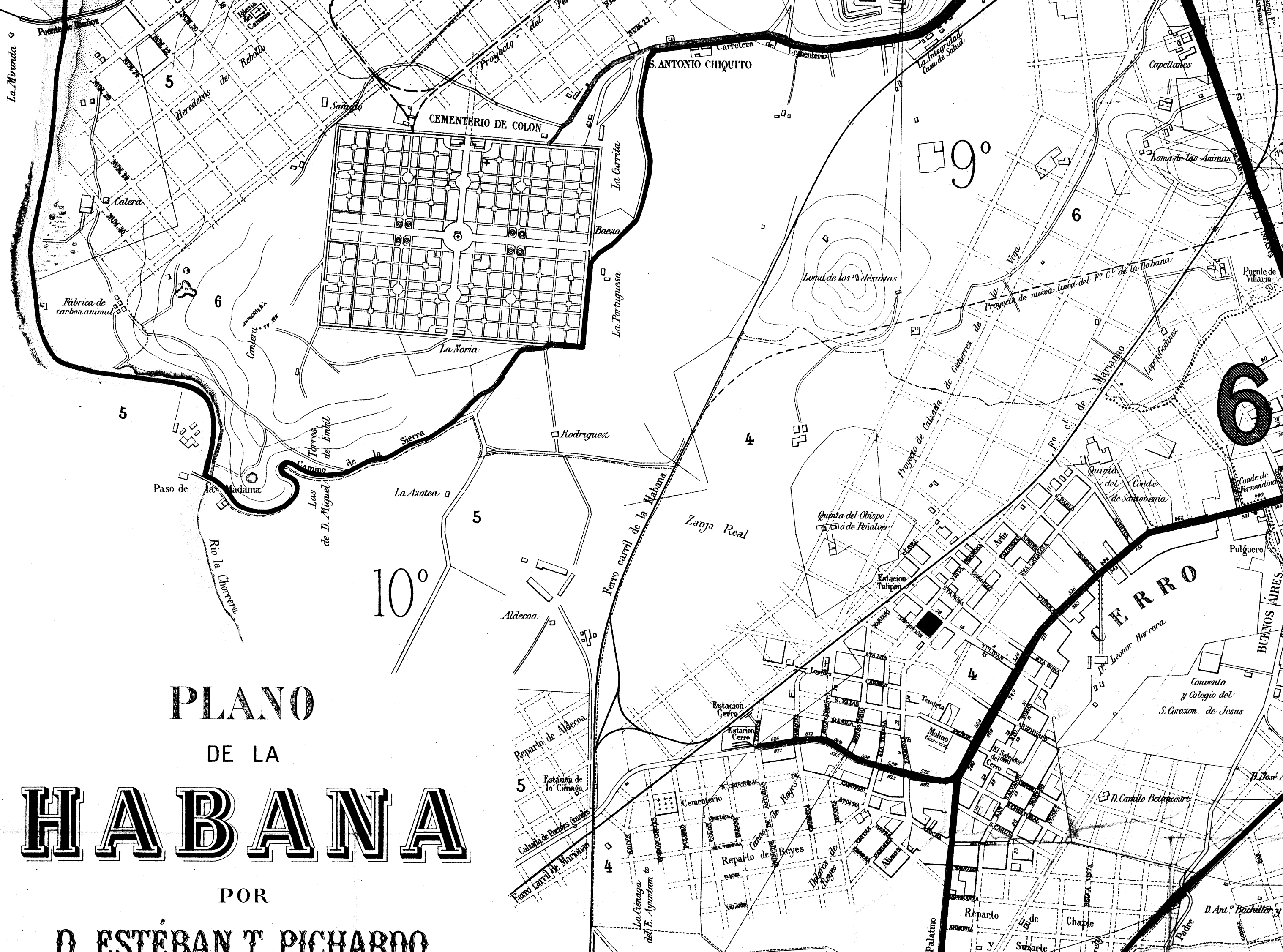
Castillo del Morro
Su Faro está situado a las
23° 9' 24" 7 Latitud N.
76° 9' 10" de S. Fernando
Su luz se divisa desde el mar
a 18 millas = 33 1/2 kilómetros



Varas cubanas
Escala 10.000

8





PLANO

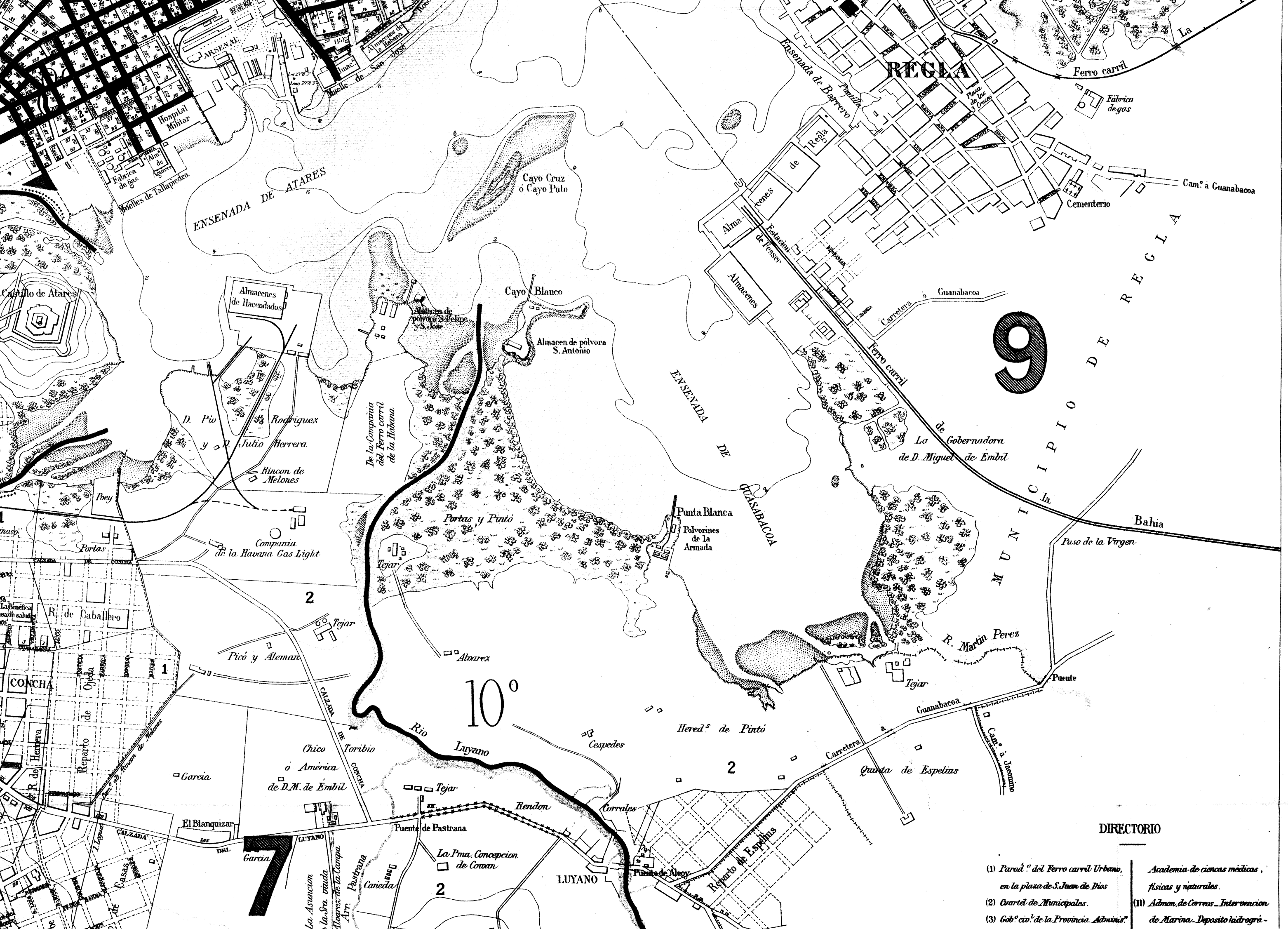
DE LA

HABANA

POR

D. ESTEBAN T. PICHARRO





DIRECTORIO

- | | |
|----------------------------------------------------------------------|-------------------------------------------------------------------------|
| (1) Parada del Ferrocarril Urbano, en la plaza de S. Juan de Dios | Academia de ciencias médicas, físicas y naturales. |
| (2) Cuartel de Municipales. | (II) Admon. de Correos - Intervención de Marina - Depósito hidrográ- |
| (3) Gobierno de la Provincia. Adminis. | |

PLANO DE LA HABANA

POR

D. ESTEBAN T. PICHARDO,

AGRIMENSOR Y MAESTRO DE OBRAS.

EDITOR: D. JOSÉ VALDEPARES.

Para la formacion de este Plano, se han tenido presentes el publicado por el Excmo. Ayuntamiento, el del Puerto por los Ingenieros de Obras publicas, y otros debidos a los Sres. D. Mariano Carles, D. José Ocampo, D. J. Manuel Alvaro, D. Alberto de Castro, D. Antonio Ariza, D. José Lopez Trigo, D. José C. del Castillo, D. Simon Teja & ; cuyos trabajos ha combinado el Autor del presente, añadiendo los que practicó expofeso sobre el terreno.

Las curvas de igual sonda, dibujadas en el Puerto, indican la profundidad del agua de dos en dos metros, en baja mar, y están deducidas del sondeo verificado por O. públicas en 1874.

- Estac^{ta} telegrafica
- Caja de agua
- Caja y sifon
- Sifon
- Ferrocarril en explotacion
- Idem en proyecto
- Parroquia
- Límite Municipal
- Idem de Distrito municipal
- Idem de Barrio
- Idem de Parroquia

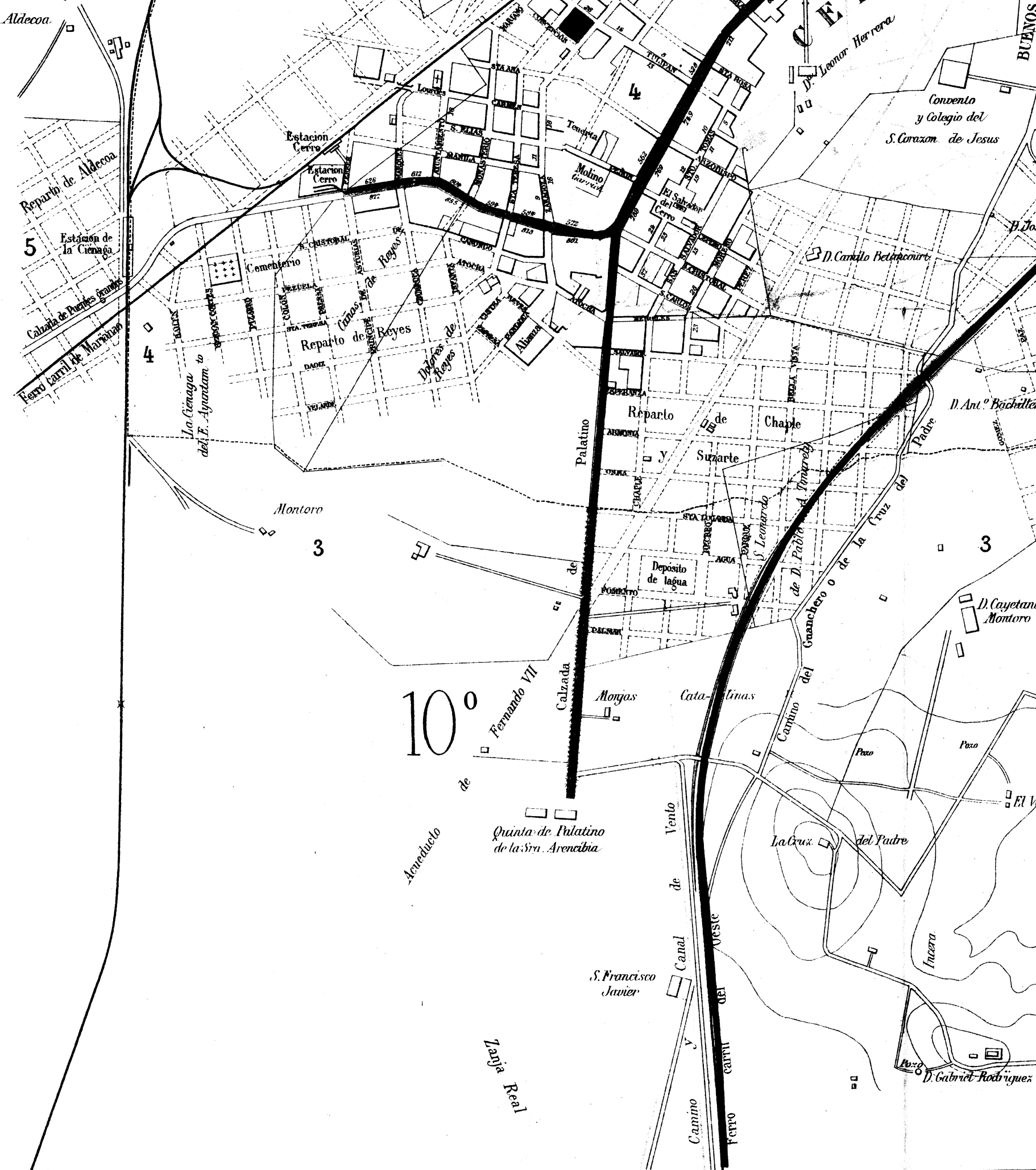
Servicio
de Bomberos

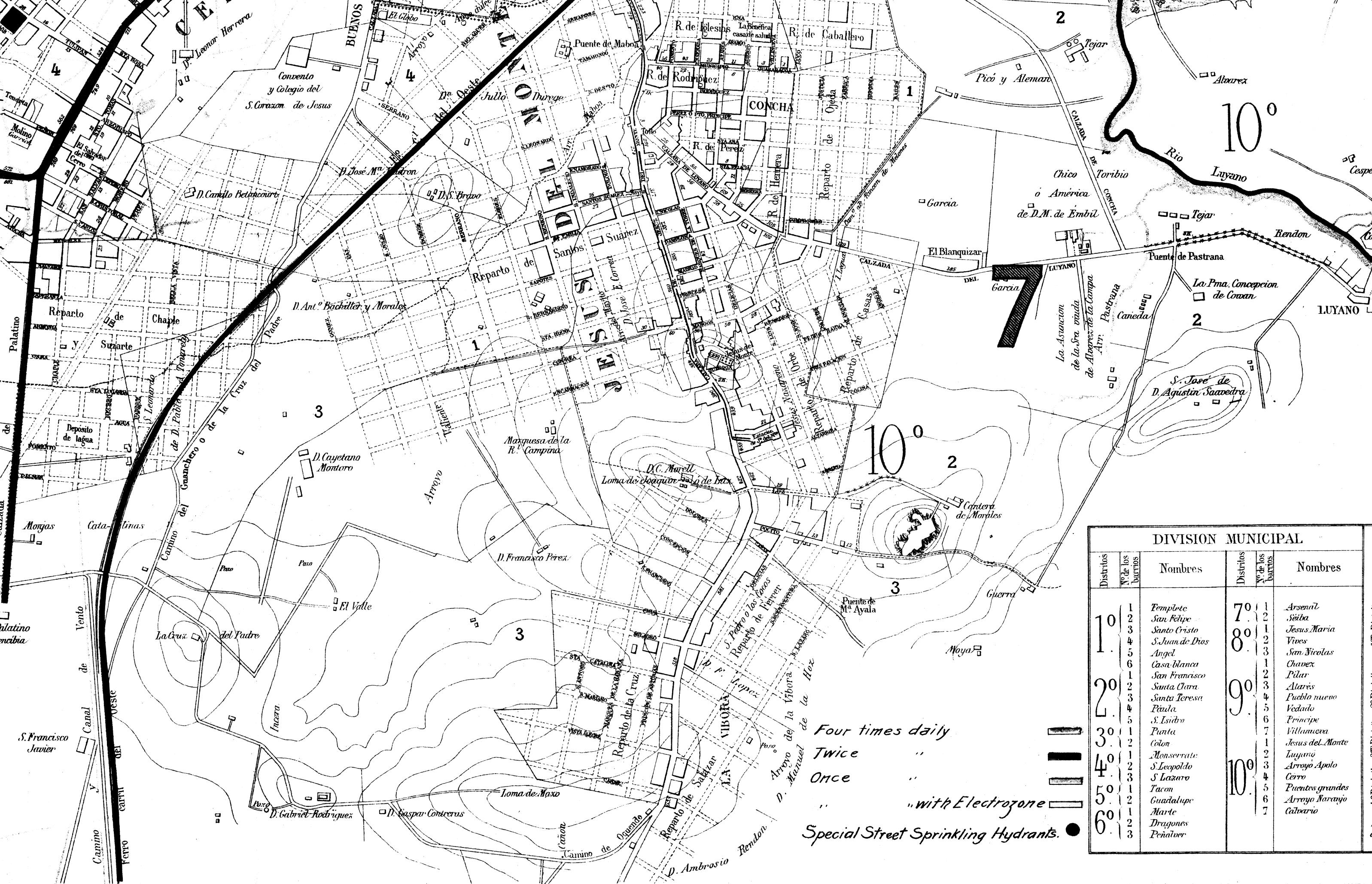
Los números de las casas corresponden al último de cada frente de manzana, y están escritos en carácter itálico, como 1, 2, 3, 4.

Los que se refieren a la numeracion del Directorio, están escritos en carácter romano, y entre paréntesis: (1) (2) (3) (4).

Los ordinales de los Distritos municipales son de carácter capitales y tamaño grande: 1^o.

Los de los barrios son de carácter romano, mayores que los del Directorio: 1, 2, 3.





| DIVISION MUNICIPAL | | | | | |
|--------------------|-------------------|-----------------|-----------|-------------------|-----------------|
| Distritos | Nº de los barrios | Nombres | Distritos | Nº de los barrios | Nombres |
| 1º | 1 | Templete | 7º | 1 | Arsenal |
| | 2 | San Felipe | | 2 | Santa |
| | 3 | Santo Cristo | | 3 | Jesus Maria |
| | 4 | S. Juan de Dios | 8º | 1 | Vives |
| | 5 | Angel | | 2 | San Nicolas |
| | 6 | Casa Blanca | | 3 | Chavez |
| 2º | 1 | San Francisco | 9º | 1 | Pilar |
| | 2 | Santa Clara | | 2 | Alarés |
| | 3 | Santa Teresa | | 3 | Pueblo nuevo |
| | 4 | Paula | | 4 | Vedado |
| | 5 | S. Lsido | | 5 | Principe |
| 3º | 1 | Punta | 10º | 6 | Villamiera |
| | 2 | Colon | | 7 | Jesus del Monte |
| 4º | 1 | Montserrat | | 1 | Lujano |
| | 2 | S. Leopoldo | | 2 | Arroyo Apolo |
| 5º | 1 | S. Lazaro | | 3 | Cerro |
| | 2 | Tacon | | 4 | Puentes grandes |
| 6º | 1 | Guadalupe | | 5 | Arroyo Narayon |
| | 2 | Marte | | 6 | Calvario |
| | 3 | Peñalver | | | |

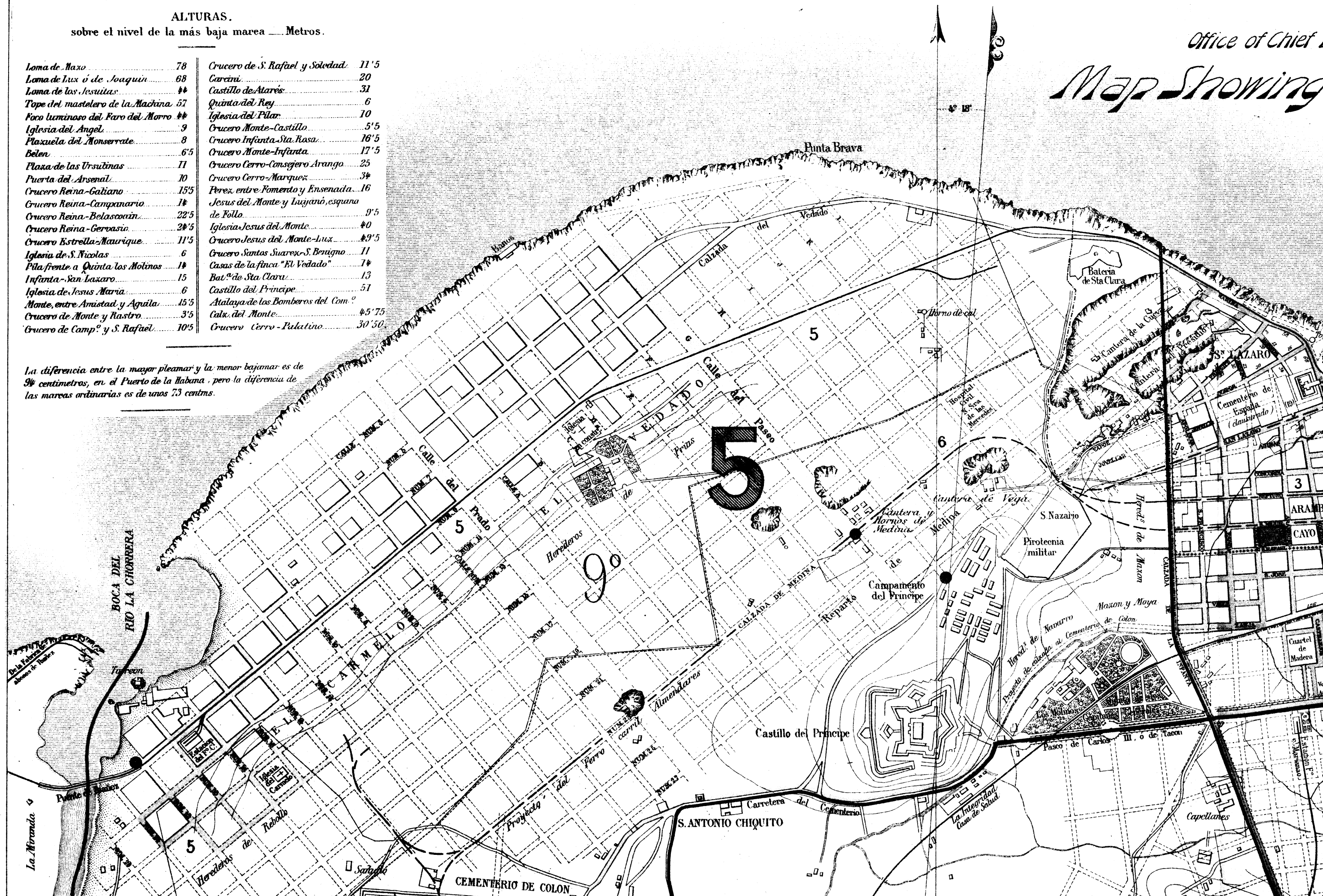
ALTURAS.
sobre el nivel de la más baja marea — Metros.

| | | | |
|---------------------------------------|------|---------------------------------------|-------|
| Loma de Maso..... | 78 | Crucero de S. Rafael y Soledad..... | 11'5 |
| Loma de Lux ó de Joaquín..... | 68 | Carcini..... | 20 |
| Loma de los Jesuitas..... | 44 | Castillo de Alarés..... | 31 |
| Tope del mastelero de la Máquina..... | 57 | Quinta del Rey..... | 6 |
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| Crucero Reina-Gervasio..... | 24'5 | Iglesia Jesus del Monte..... | 40 |
| Crucero Estrella-Maurique..... | 11'5 | Crucero Jesus del Monte-Lux..... | 49'5 |
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La diferencia entre la mayor pleamar y la menor bajamar es de 94 centímetros, en el Puerto de la Habana, pero la diferencia de las mareas ordinarias es de unos 73 centms.

Office of Chief

Map Showing



Map Showing Street Cleaning.

Office of Chief Engineer-City of Havana

Map Showing Street Cleaning.

Castillo del Morro
Su Faro está situado a las
23° 9' 24" 7 Latitud N. y
76° 9' 70" de S. Fernando.
Su luz se divisa desde el mar
a 18 millas = 33 1/2 kilometros

Map showing the city of Havana, Cuba, with street cleaning areas marked by large numbers 1, 2, 3, and 4. The map includes various landmarks and geographical features, such as the Castillo del Morro, Castillo de la Punta, Bateria de Sta Clara, Bateria de la Reina, and the harbor area. The map is oriented with the city's main axis running from the harbor in the north to the interior in the south. Key features include the Castillo del Morro and Castillo de la Punta in the north, the harbor area with the Bateria de Sta Clara and Bateria de la Reina, and the city grid with streets labeled with numbers. Large numbers 1, 2, 3, and 4 are prominently displayed on the map, likely indicating specific areas of interest for street cleaning. The map also shows the city's expansion towards the south and west, including the area around the Bateria de Sta Clara and the Bateria de la Reina. The map is a black and white line drawing with a grid system for street numbering.

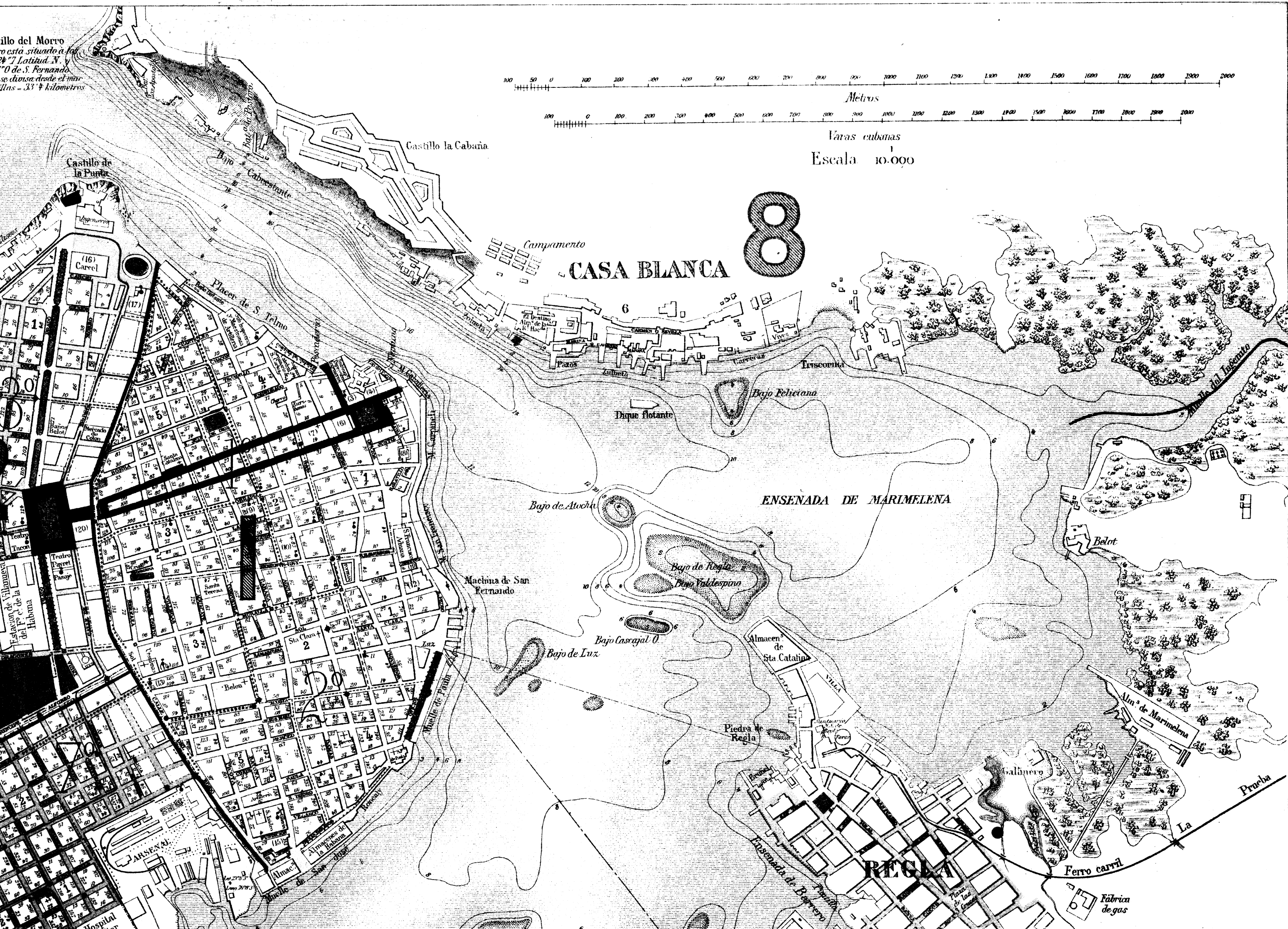
Castillo del Morro
está situado a 1/2 milla
de S. Fernando
se divide desde el mar
en 33 1/2 kilómetros

100 50 0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000

Metros

100 0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000

Varas cubanas
Escala 10.000



PLANO
DE LA
HABANA

POR

D. ESTEBAN T. PICHARDO,

ACRIMENCOR Y MAESTRO DE OBRAS







9

7

10°

DIRECTORIO

- (1) Parada del Ferrocarril Urbano, en la plaza de S. Juan de Dios
- (2) Cuartel de Municipales.

Academia de ciencias médicas, físicas y naturales.
(11) Admon. de Correos - Intervención

PLANO DE LA HABANA

POR
D. ESTEBAN T. PICHARDO,

AGRIMENSOR Y MAESTRO DE OBRAS.

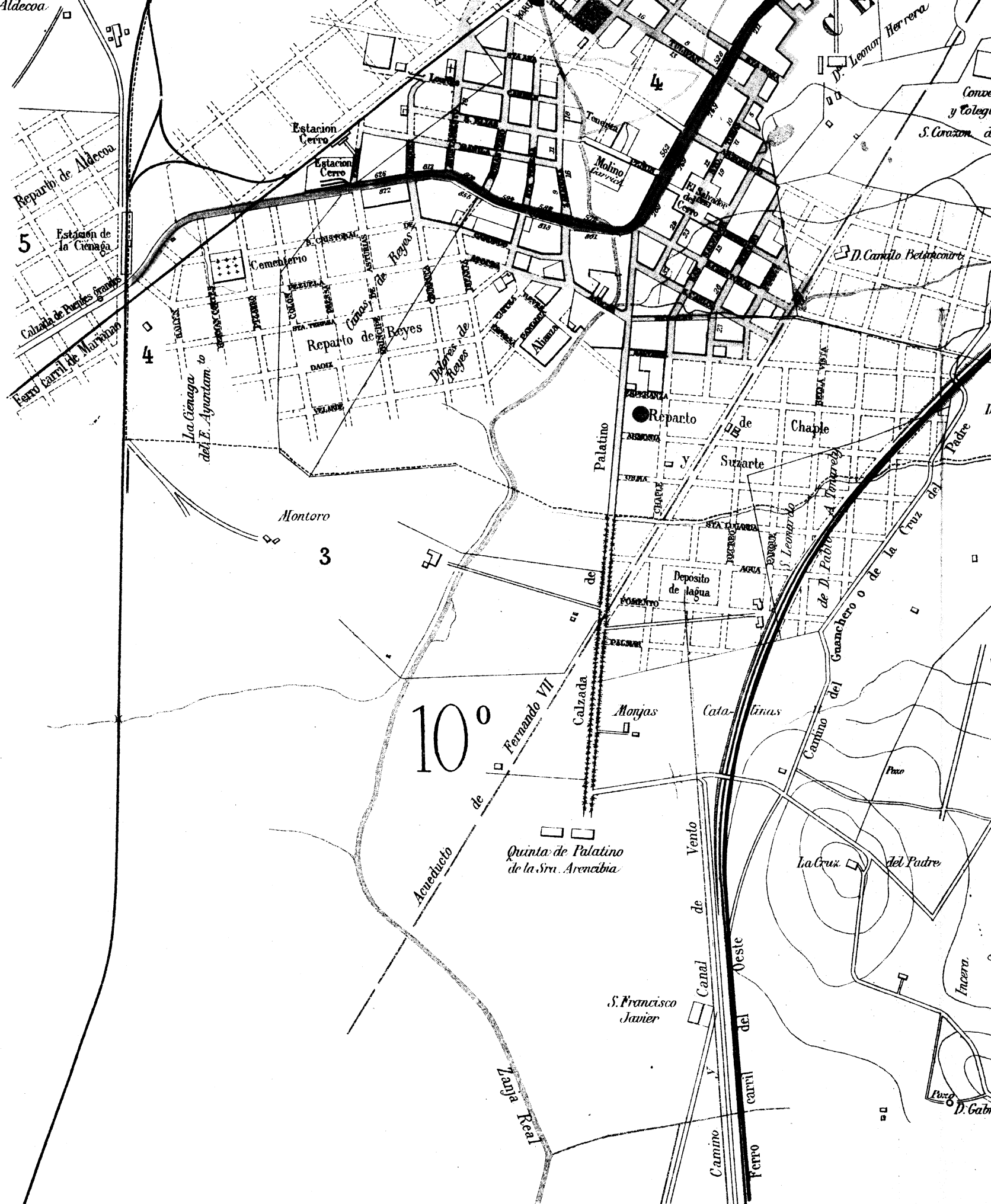
EDITOR: D. JOSÉ VALDEPARES.

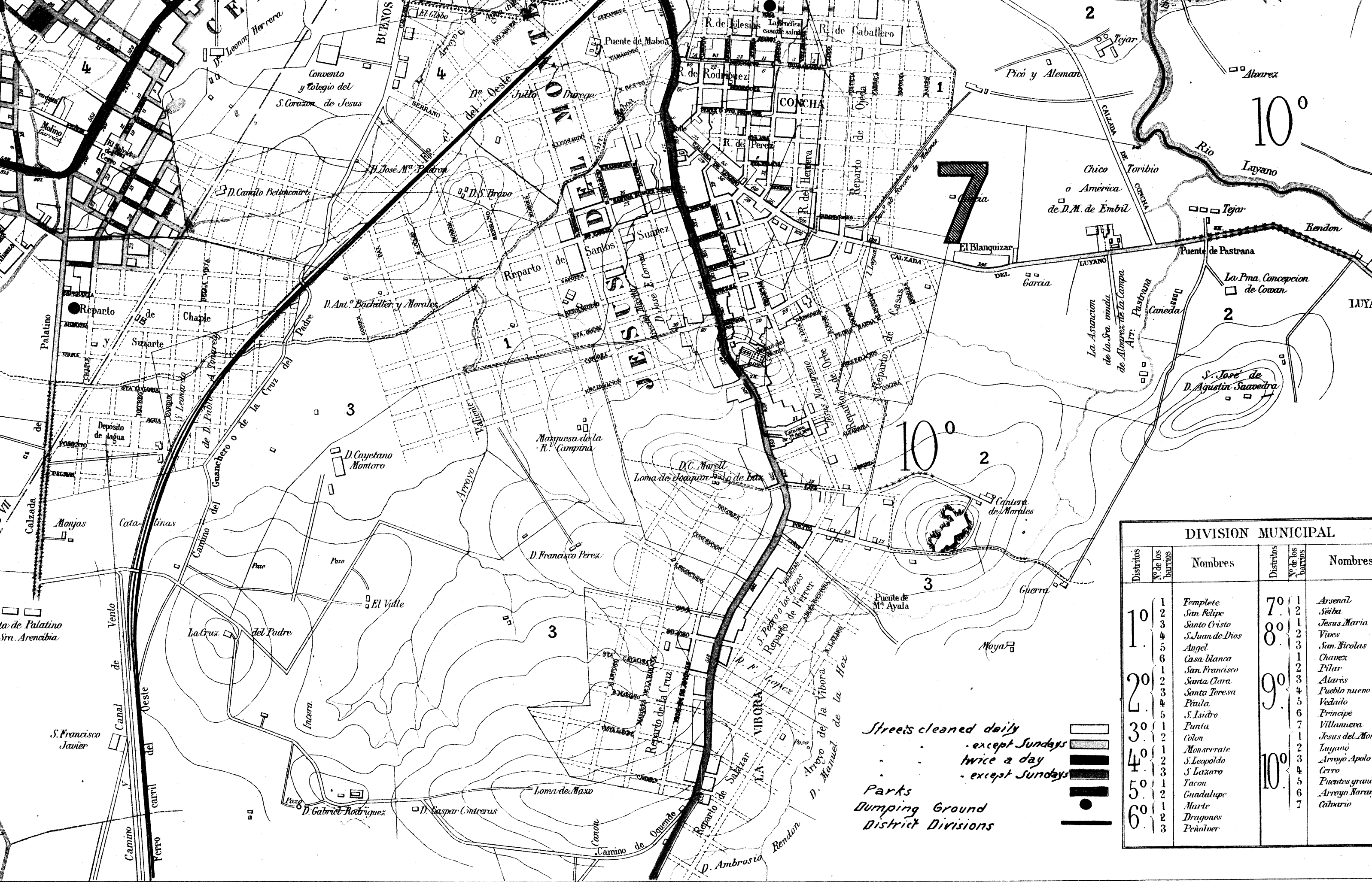
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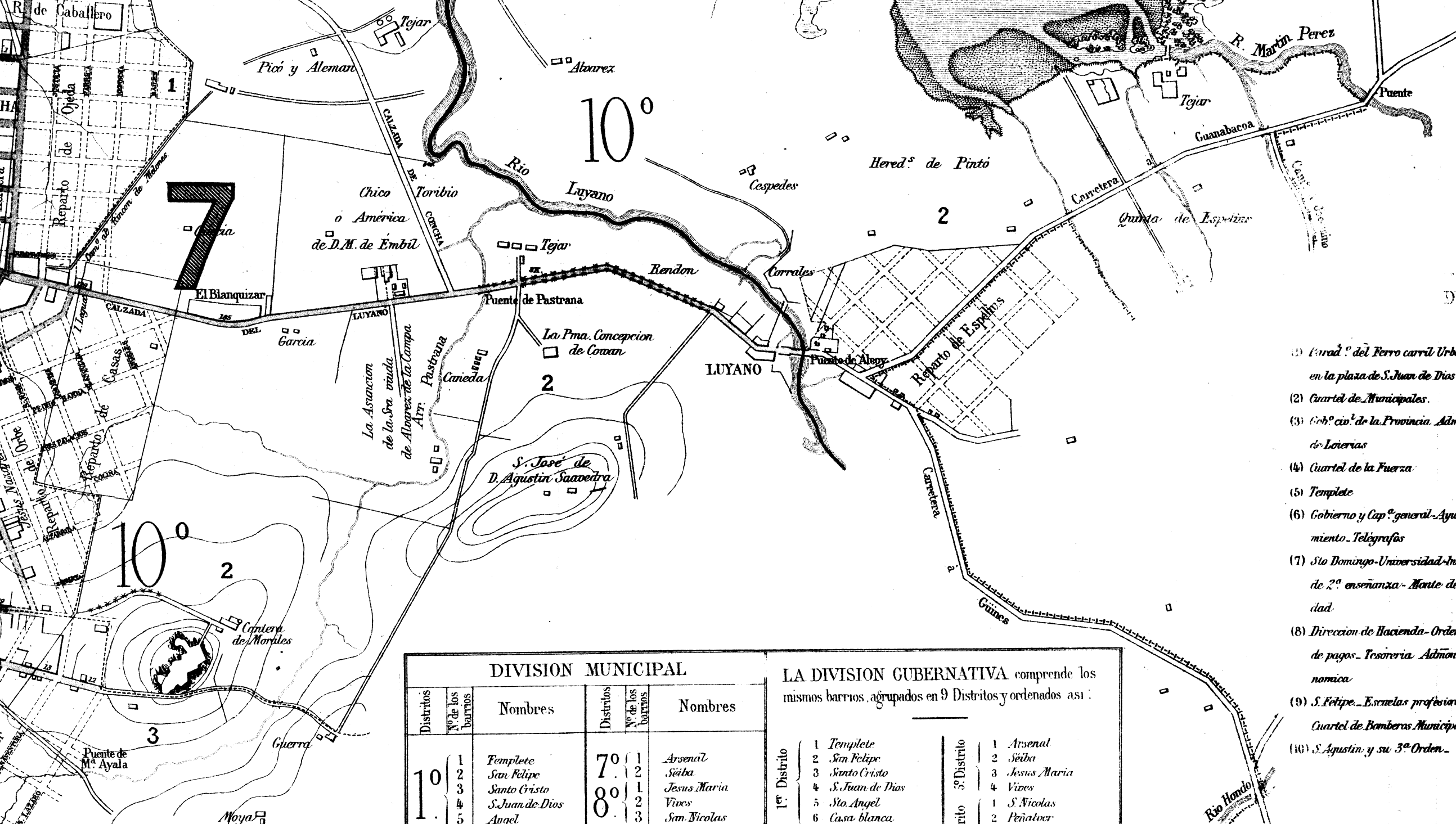
- Estac. telegráfica
- Caja de agua
- Caja y sifón
- Sifón
- Ferro carril en explotacion
- Idem en proyecto
- Parroquia
- Límite Municipal
- Idem de Distrito municipal
- Idem de Barrio
- Idem de Parroquia

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| DIVISION MUNICIPAL | | | | | |
|--------------------|-------------------|-----------------|-----------|-------------------|----------------|
| Districts | Nº de los barrios | Nombres | Districts | Nº de los barrios | Nombres |
| 1º | 1 | Templete | 7º | 1 | Arsenal |
| | 2 | San Felipe | | 2 | Saiba |
| | 3 | Santo Cristo | | 1 | Jesus Maria |
| | 4 | S. Juan de Dios | | 2 | Vives |
| | 5 | Angel | | 3 | San Nicolas |
| 2º | 6 | Casa blanca | 8º | 1 | Chavez |
| | 1 | San Francisco | | 2 | Pilar |
| | 2 | Santa Clara | | 3 | Alarís |
| | 3 | Santa Teresa | | 4 | Pueblo nuevo |
| | 4 | Paula | | 5 | Vedado |
| 3º | 5 | S. Isidro | 9º | 6 | Principe |
| | 1 | Punta | | 7 | Villanueva |
| | 2 | Colon | | 1 | Jesus del. Mor |
| | 1 | Monseratte | | 2 | Luyano |
| | 2 | S. Leopoldo | | 3 | Arroyo Apolo |
| 4º | 3 | S. Lorenzo | 10º | 4 | Cerro |
| | 1 | Tacon | | 5 | Puentes gran |
| | 2 | Guadalupe | | 6 | Arroyo Naray |
| | 1 | Marte | | 7 | Cathario |
| | 2 | Dragones | | | |
| 6º | 3 | Peñalver | | | |



| DIVISION MUNICIPAL | | | | | |
|--------------------|-------------------|-----------------|------------|-------------------|-----------------|
| Districtos | Nº de los barrios | Nombres | Districtos | Nº de los barrios | Nombres |
| 1º | 1 | Templete | 7º | 1 | Arsenal |
| | 2 | San Felipe | | 2 | Saba |
| | 3 | Santo Cristo | | 3 | Jesus Maria |
| | 4 | S. Juan de Dios | | 4 | Vives |
| | 5 | Angel | | 5 | San Nicolas |
| 2º | 6 | Casa blanca | 8º | 1 | Chavez |
| | 1 | San Francisco | | 2 | Pilar |
| | 2 | Santa Clara | | 3 | Alarés |
| | 3 | Santa Teresa | | 4 | Pueblo nuevo |
| | 4 | Paula | | 5 | Vedado |
| 3º | 5 | S. Isidro | 9º | 6 | Principe |
| | 1 | Punta | | 7 | Villanueva |
| | 2 | Colon | | 1 | Jesus del Monte |
| | 3 | Monserate | | 2 | Luyano |
| | 4 | S. Leopoldo | | 3 | Arroyo Apolo |
| 4º | 5 | S. Lazaro | 10º | 4 | Cerro |
| | 1 | Tacon | | 5 | Puentes grandes |
| | 2 | Guadalupe | | 6 | Arroyo Naranjo |
| | 3 | Marte | | 7 | Calvario |
| | 4 | Dragones | | | |
| 5º | 1 | Peñalver | | | |
| | 2 | | | | |
| 6º | 3 | | | | |
| | 4 | | | | |

LA DIVISION GUBERNATIVA comprende los mismos barrios, agrupados en 9 Districtos y ordenados así:

| | | |
|-------------|---|-----------------|
| 1º Distrito | 1 | Templete |
| | 2 | San Felipe |
| | 3 | Santo Cristo |
| | 4 | S. Juan de Dios |
| | 5 | S. Angel |
| | 6 | Casa blanca |
| 2º Distrito | 1 | San Francisco |
| | 2 | Santa Clara |
| | 3 | Santa Teresa |
| | 4 | Paula |
| | 5 | San Isidro |
| | 6 | Principe |
| 3º Distrito | 1 | Punta |
| | 2 | Colon |
| | 3 | Tacon |
| | 4 | Marte |
| | 5 | Monserate |
| | 6 | Dragones |
| 4º Distrito | 1 | Guadalupe |
| | 2 | S. Leopoldo |
| | 3 | |
| | 4 | |
| | 5 | |
| | 6 | |
| 5º Distrito | 1 | Arsenal |
| | 2 | Saba |
| | 3 | Jesus Maria |
| | 4 | Vives |
| | 5 | S. Nicolas |
| | 6 | Peñalver |
| 6º Distrito | 1 | Chavez |
| | 2 | Pilar |
| | 3 | Alarés |
| | 4 | Pueblo nuevo |
| | 5 | Vedado |
| | 6 | Principe |
| 7º Distrito | 1 | Jesus del Monte |
| | 2 | Luyano |
| | 3 | Arroyo Apolo |
| | 4 | Villanueva |
| | 5 | Cerro |
| | 6 | |
| 8º Distrito | 1 | |
| | 2 | |
| | 3 | |
| | 4 | |
| | 5 | |
| | 6 | |
| 9º Distrito | 1 | |
| | 2 | |
| | 3 | |
| | 4 | |
| | 5 | |
| | 6 | |

Puentes grandes, Arroyo Naranjo y Calvario estaban como Pedanías, no incluidas en los 9 Districtos.

DIRECTORIO

- (1) Carretera del Ferro carril Urbano, en la plaza de S. Juan de Dios
- (2) Cuartel de Municipales.
- (3) Gob.º civ.º de la Provincia. Adminis.º de Leñeras
- (4) Cuartel de la Fuerza
- (5) Templete
- (6) Gobierno y Cap.º general. Ayuda. miento. Telégrafos
- (7) Sto Domingo-Universidad-Instituto de 2.ª enseñanza. Monte de piedad.
- (8) Direccion de Hacienda-Orden.º de pagos. Tesoreria. Admón. Económica
- (9) S. Felipe. Escuelas profesionales. Cuartel de Bomberos Municipales
- (10) S. Agustín y su 3.ª Orden.
- (11) Academia de ciencias medicas, fisicas y naturales.
- (12) Admon. de Correos. Intervencion de Marina. Deposito hidrográfico
- (13) Comand.º gral. del Apastadero
- (14) Cuartelillo Bomb.º municipales
- (15) Cuartel Bomb.º del Comercio
- (16) Casa de Recogidas, de S. Juan Nepomuceno
- (17) Carcel. Presidio. Hospital civil de S. Felipe y Santiago
- (18) Morque o Necroscopia. Obras municipales
- (19) Asilo de S. José, de Artes y Oficios
- (20) Teatro de Albizu, o de Llerandi. Casino español
- (21) Cuartel de la Guardia civil

Office of Chief Engineer
Division of Cuba.
To accompany Report of June 30th, 1900.
M M Bush
Major Corps of Engineers U.S.A.
Chief Engineer

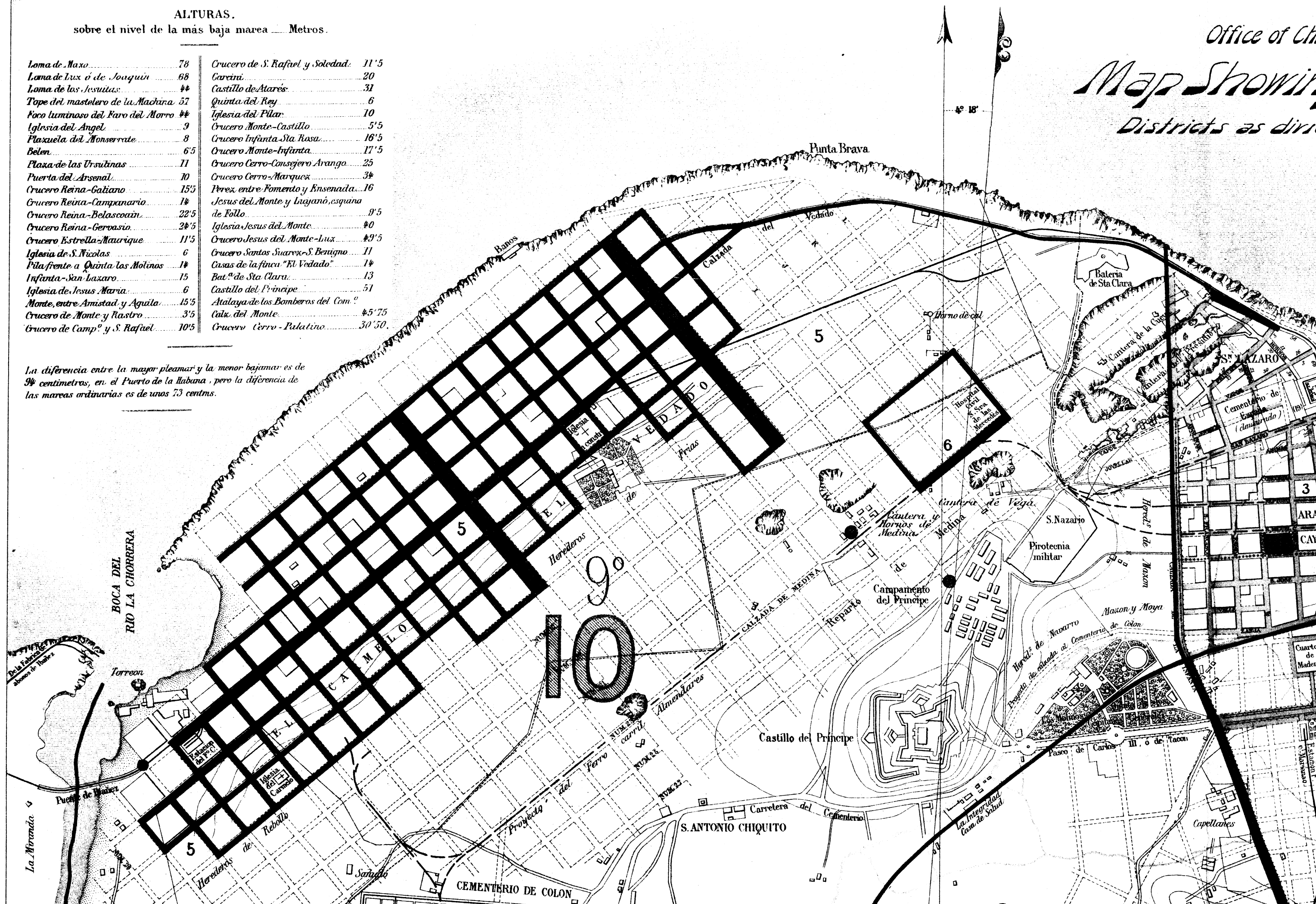
Streets cleaned daily
except Sundays
twice a day
except Sundays

Parks
Dumping Ground
District Divisions

sobre el nivel de la más baja marea ____ Metros.

| | | | |
|---------------------------------------|------|---------------------------------------|-------|
| Loma de Maxo..... | 78 | Crucero de S. Rafael y Soledad..... | 11'5 |
| Loma de Lux ó de Joaquín..... | 68 | Carreón..... | 20 |
| Loma de los Jesuitas..... | 44 | Castillo de Atarés..... | 31 |
| Tope del mastelero de la Máquina..... | 57 | Quinta del Rey..... | 6 |
| Foco luminoso del Faro del Morro..... | 44 | Iglesia del Pilar..... | 10 |
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| Plaxuela del Monserrate..... | 8 | Crucero Infanta Sta. Rosa..... | 16'5 |
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| Infanta-San Lázaro..... | 15 | Bat.ª de Sta. Clara..... | 13 |
| Iglesia de Jesus Maria..... | 6 | Castillo del Principe..... | 51 |
| Monte, entre Amistad y Aguila..... | 15'5 | Atalaya de los Bomberos del Com.º | |
| Crucero de Monte y Rastro..... | 3'5 | Calk. del Monte..... | 45'75 |
| Crucero de Camp.º y S. Rafael..... | 10'5 | Crucero Cerro-Pulativo..... | 30'50 |

La diferencia entre la mayor pleamar y la menor bajamar es de 94 centímetros; en el Puerto de la Ilabana, pero la diferencia de las mareas ordinarias es de unos 73 centms.

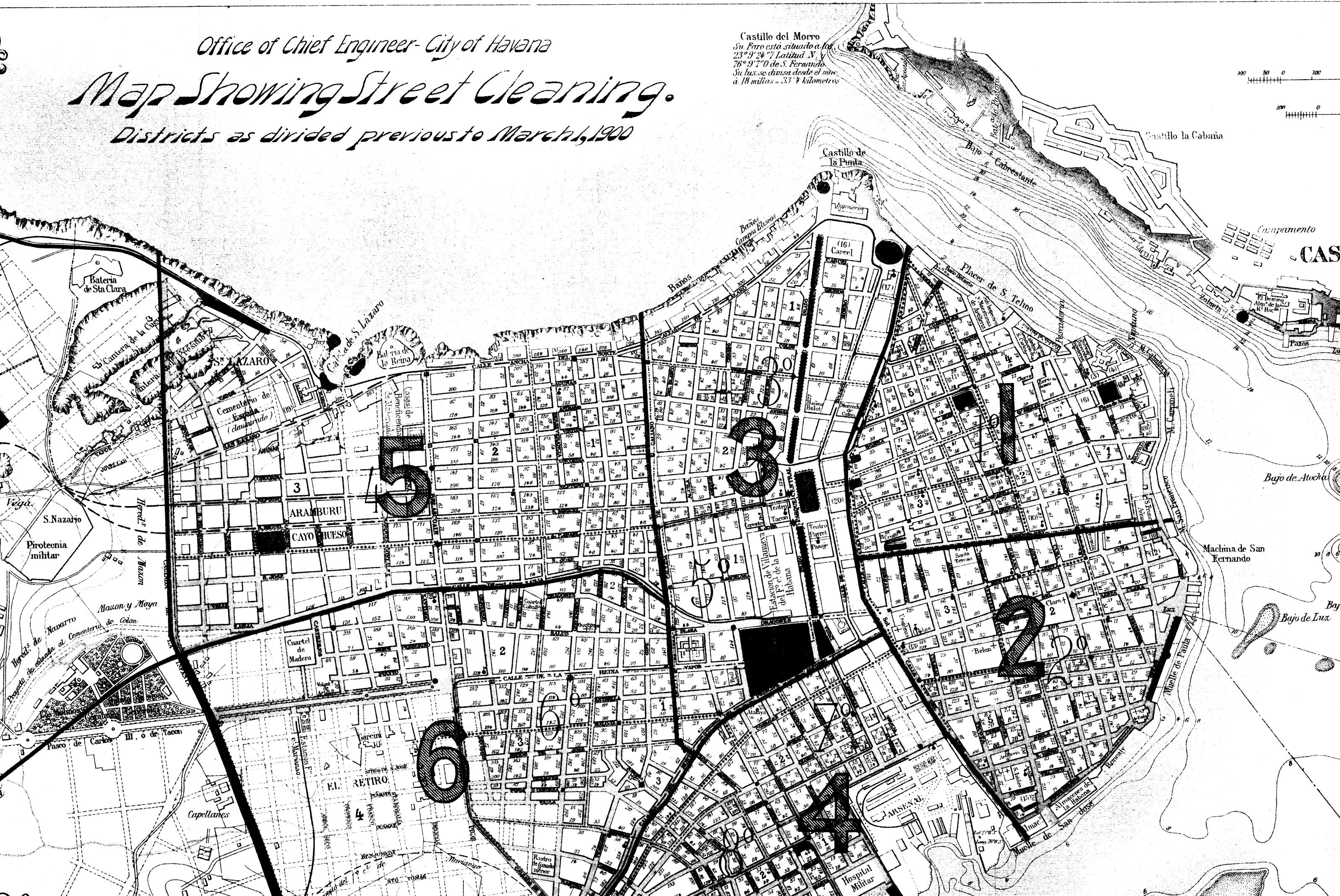


Office of Chief Engineer-City of Havana

Map Showing Street Cleaning.

Districts as divided previous to March 1, 1900

Castillo del Morro
Su Faro esta situado a las
23° 9' 24" Latitud N. y
76° 9' 7" 0 de S. Fernando
Su luz se divisa desde el mar
a 18 millas = 33 1/2 kilometros



Castillo del Morro
Su Faro está situado a las
23° 9' 24" 7 Latitud N. y
76° 9' 7" 0 de S. Fernando
Su luz se divisa desde el mar
a 18 millas - 33 1/2 kilometros



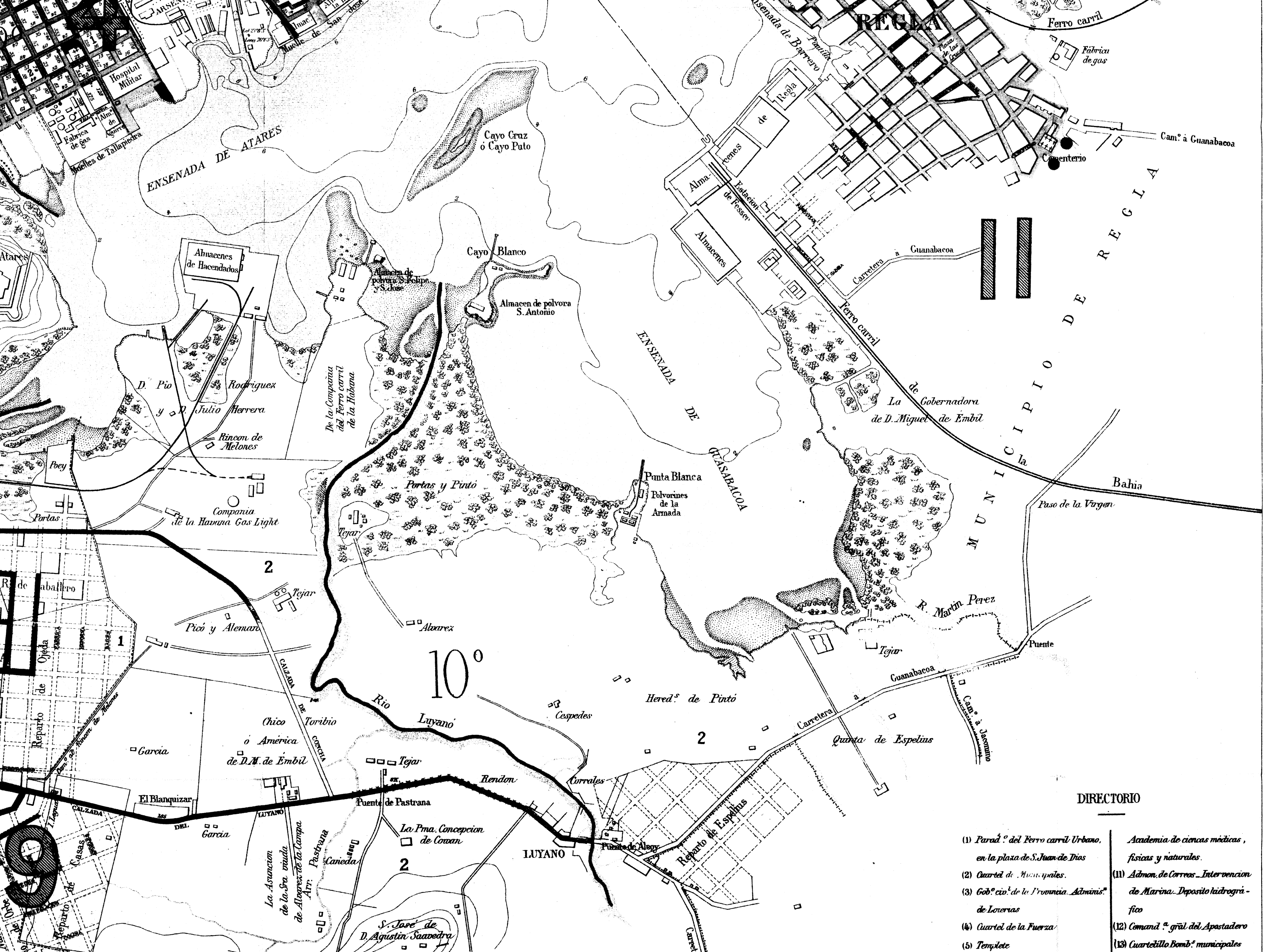
Varas cubanas
Escala 10.000

12

CASA BLANCA



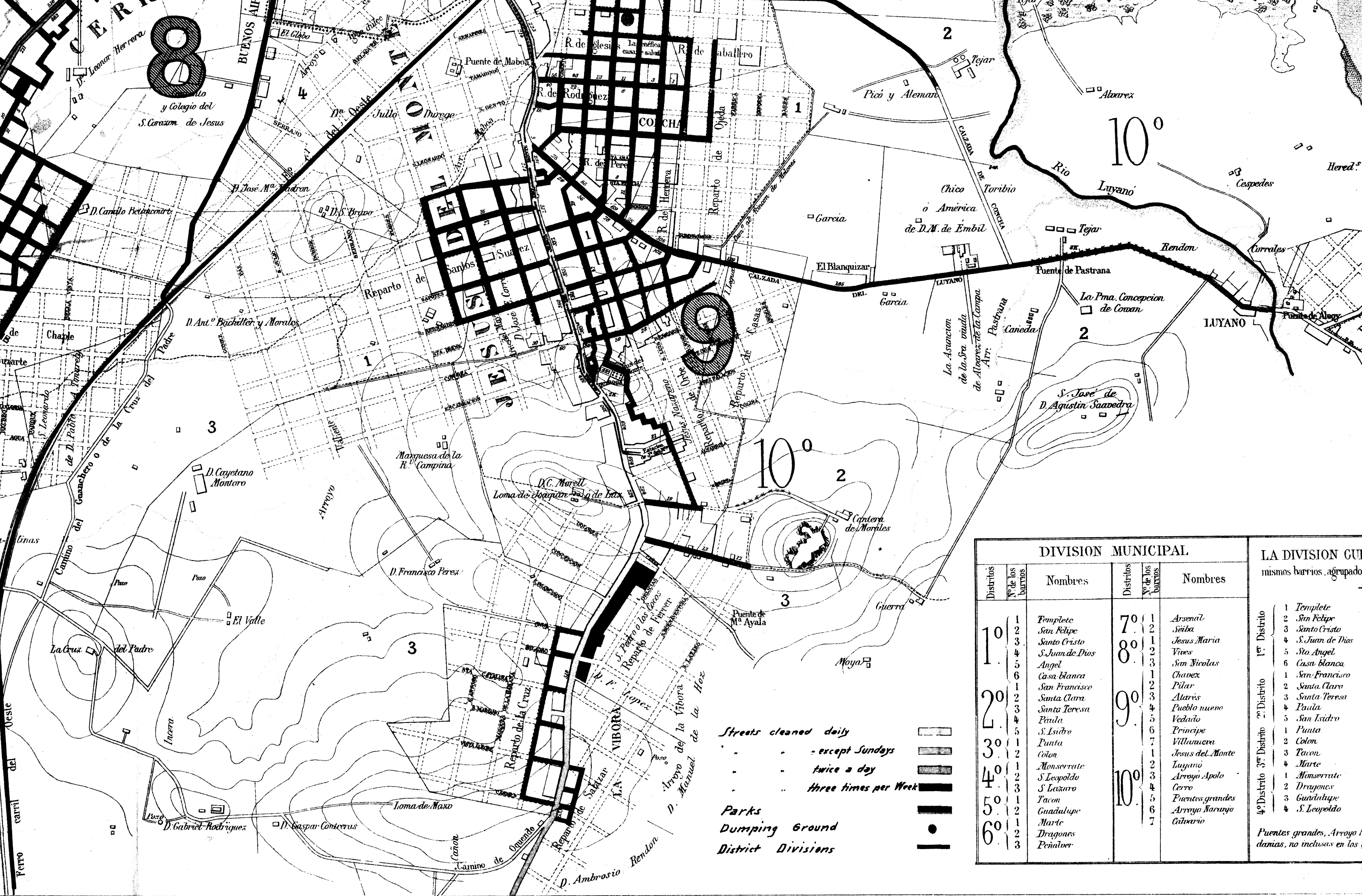




HABANA

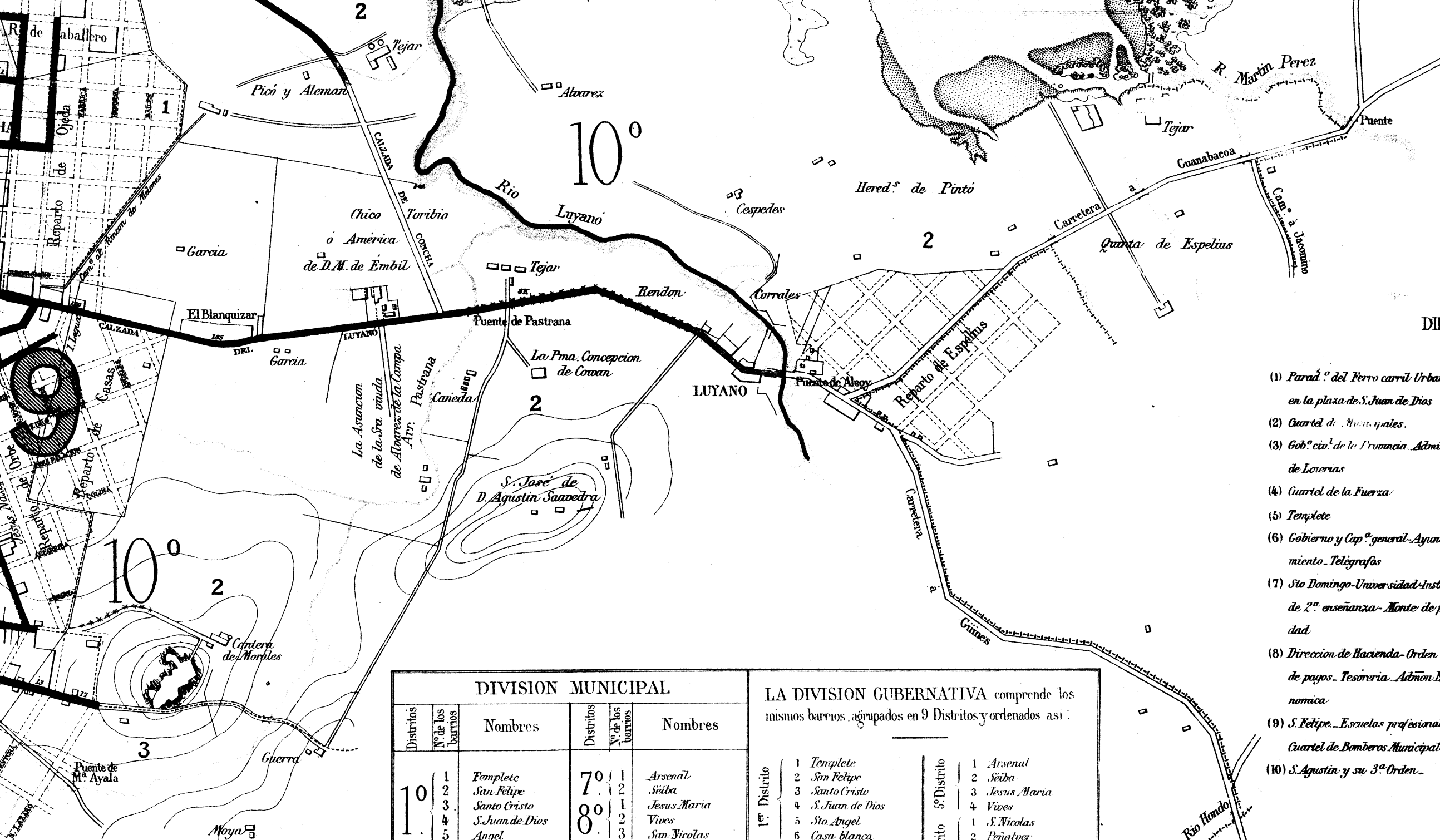
AGRIMENSOR Y MAESTRO DE OBRAS.

[illegible]



| DIVISION MUNICIPAL | | | | LA DIVISION CU | | | |
|--------------------|-------------------|-----------------|--|----------------|-------------------|-----------------|--|
| Districts | Nº de los barrios | Nombres | | Districts | Nº de los barrios | Nombres | |
| 1º | 1 | Templete | | 7º | 1 | Arsenal | |
| | 2 | San Felipe | | | 2 | Seiba | |
| | 3 | Santo Cristo | | 8º | 1 | Jesus Maria | |
| | 4 | S. Juan de Dios | | | 2 | Vines | |
| | 5 | Angel | | | 3 | San Nicolas | |
| | 6 | Casa blanca | | | 1 | Chavex | |
| | 1 | San Francisco | | | 2 | Pilar | |
| 2º | 1 | Santa Clara | | 9º | 3 | Altaviz | |
| | 2 | Santa Teresa | | | 4 | Pueblo nuevo | |
| | 3 | Piñola | | | 5 | Vedado | |
| | 4 | S. Isidro | | | 6 | Principe | |
| | 5 | Punta | | | 1 | Villanueva | |
| 3º | 1 | Monserate | | | 2 | Jesus del Monte | |
| | 2 | S. Leopoldo | | 10º | 3 | Luyano | |
| | 3 | S. Lorenzo | | | 4 | Arroyo Apolo | |
| 4º | 1 | Tacon | | | 5 | Cerro | |
| | 2 | Guadalupe | | | 6 | Puentes grandes | |
| | 3 | Marte | | | 7 | Arroyo Narayao | |
| 5º | 1 | Dragones | | | | Cañavio | |
| 6º | 2 | Peñalver | | | | | |

Puentes grandes, Arroyo Narayao, no incluidas en las divisiones.



| DIVISION MUNICIPAL | | | | | |
|--------------------|-------------------|-----------------|------------|-------------------|-----------------|
| Districtos | Nº de los barrios | Nombres | Districtos | Nº de los barrios | Nombres |
| 1º | 1 | Templete | 7º | 1 | Arsenal |
| | 2 | San Felipe | | 2 | Seiba |
| | 3 | Santo Cristo | | 1 | Jesus Maria |
| | 4 | S. Juan de Dios | | 2 | Vives |
| | 5 | Angel | | 3 | San Nicolas |
| 2º | 6 | Casa Blanca | 8º | 1 | Chavez |
| | 1 | San Francisco | | 2 | Pilar |
| | 2 | Santa Clara | | 3 | Alarés |
| | 3 | Santa Teresa | | 4 | Pueblo nuevo |
| | 4 | Paula | | 5 | Vedado |
| 3º | 5 | S. Isidro | 9º | 6 | Principe |
| | 1 | Punta | | 7 | Villanueva |
| | 2 | Colon | | 1 | Jesus del Monte |
| | 1 | Monserate | | 2 | Luyano |
| | 2 | S. Leopoldo | 10º | 3 | Arroyo Apolo |
| 4º | 3 | S. Lazaro | | 4 | Cerro |
| | 1 | Tacon | | 5 | Puentes grandes |
| | 2 | Guadalupe | | 6 | Arroyo Narunjo |
| | 1 | Marte | | 7 | Calvario |
| 5º | 1 | Dragones | | | |
| | 2 | Penalver | | | |
| | 3 | | | | |
| 6º | 1 | | | | |
| | 2 | | | | |
| | 3 | | | | |

LA DIVISION GUBERNATIVA comprende los mismos barrios, agrupados en 9 Districtos y ordenados así:

| | | | |
|-------------|-------------------|--------------|-------------------|
| 1º Distrito | 1 Templete | 5º Distrito | 1 Arsenal |
| 2º Distrito | 2 San Felipe | 6º Distrito | 2 Seiba |
| 3º Distrito | 3 Santo Cristo | 7º Distrito | 3 Jesus Maria |
| 4º Distrito | 4 S. Juan de Dios | 8º Distrito | 4 Vives |
| 5º Distrito | 5 Sta. Angel | 9º Distrito | 1 S. Nicolas |
| 6º Distrito | 6 Casa blanca | 10º Distrito | 2 Penalver |
| 7º Distrito | 1 San Francisco | | 3 Chavez |
| 8º Distrito | 2 Santa Clara | | 4 Pilar |
| 9º Distrito | 3 Santa Teresa | | 5 Alarés |
| | 4 Paula | | 1 S. Lazaro |
| | 5 San Isidro | | 2 Pueblo nuevo |
| | 1 Punta | | 3 Principe |
| | 2 Colon | | 4 Vedado |
| | 3 Tacon | | 1 Jesus del Monte |
| | 4 Marte | | 2 Luyano |
| | 1 Monserate | | 3 Arroyo Apolo |
| | 2 Dragones | | 1 Villanueva |
| | 3 Guadalupe | | 2 Cerro |
| | 4 S. Leopoldo | | |

Puentes grandes, Arroyo Narunjo y Calvario estaban como Pe-danias, no incluidas en los 9 Districtos.

DIRECTORIO

- (1) Parad.º del Ferro carril Urbano, en la plaza de S. Juan de Dios
- (2) Cuartel de Municipales
- (3) Gob.º cio.º de la Provincia. Adminis.º de Licerias
- (4) Cuartel de la Fuerza
- (5) Tempete
- (6) Gobierno y Cap.º general-Ayunta-miento-Telegrafos
- (7) Sto Domingo-Universidad-Instituto de 2.ª enseñanza-Monte de pie-dad
- (8) Direccion de Hacienda-Orden.º de pagos-Tesoreria-Admon.Eco-nomica
- (9) S. Felipe-Escuelas profesionales-Cuartel de Bomberos Municipales
- (10) S. Agustin y su 3.ª Orden.
- Academia de ciencias medicas, fisicas y naturales.
- (11) Admon. de Correos-Intervencion de Marina-Deposito hidrográ-fico
- (12) Comand.º gral. del Apostadero
- (13) Cuartelillo Bomb.º municipales
- (14) Cuartel Bomb.º del Comercio
- (15) Casa de Recogidas, de S. Juan Nepomuceno
- (16) Carcel- Presidio Hospital civil de S. Felipe y Santiago
- (17) Morque o Necrascomio Obras municipales
- (18) Asilo de S. Jose, de Artes y Oficios
- (19) Teatro de Albizu, o de Leraundi
- (20) Casino español
- (21) Cuartel de la Guardia civil

Office of Chief Engineer
Division of Cuba.

To accompany Report of June 30th, 1900.

W. M. Rush

Major Corps of Engineers, U.S.A.
Chief Engineer

organized it is divided into the following subdepartments: Street cleaning, street sprinkling, collection of refuse, disposal of refuse, care and preservation of parks, department stable No. 2, department stable No. 3, surveys, special service.

STREET CLEANING.

[Mr. A. C. Harper, superintendent from July 1, 1899, to December 31, 1899. Mr. J. C. Mehan, superintendent from January 1, 1900, to June 30, 1900.]

This branch of the work has been conducted with the greatest possible care in order, first, that the best character of work might be obtained; second, that the cost thereof might be reduced gradually to a minimum. The cleaning is necessarily done by hand, and the material removed from the streets in carts to the dumps, some of it being transferred by barges to the sea, some cremated, and some used as filling in the low places throughout the city. Special attention has been given to districts Nos. 1, 2, and 3, they being looked upon as the most important ones, on account of the heavy traffic and dense population. Almost the entire business of the city, especially of a wholesale character, is transacted within the boundary of these three districts. In addition to the wholesale and retail business places, district No. 3 (old number) includes within its boundary lines most of the city parks and promenades.

The average daily area of streets cleaned in the city and suburban districts, as per measurements completed May 1, 1900, is shown by the following tables:

City districts.

| | Square meters. |
|-----------------------------|----------------|
| Wooden-block pavement..... | 1,740 |
| Asphalt-block pavement..... | 7,764 |
| Asphalt-sheet pavement..... | 1,215 |
| Belgian-block pavement..... | 361,476 |
| Boston-block pavement..... | 42,731 |
| Cobble pavement..... | 6,195 |
| Macadam pavement..... | 765,326 |
| Brick pavement..... | 5,629 |
| Unpaved..... | 29,484 |
| Total..... | 1,221,560 |

Suburban districts.

| | Square meters. | Totals. |
|-------------------------------------|----------------|-----------|
| Cerro, Vedado, and Jesus del Monte: | | |
| Stone pavement..... | 13,231 | |
| Brick pavement..... | 273 | |
| Macadam pavement..... | 784,138 | |
| Unpaved..... | 60,491 | |
| Suburban districts..... | | 858,133 |
| City districts..... | | 1,221,560 |
| Grand total..... | | 2,079,693 |
| Casa Blanca, unpaved..... | | 30,186 |
| Regla: | | |
| Unpaved..... | 100,698 | |
| Cobble pavement..... | 6,573 | |
| Grand total..... | | 107,271 |
| | | 137,457 |

Upon the completion of the measurements of all street areas cleaned, as shown in the foregoing tables, plans for redistricting the city were inaugurated. The street areas which had previously been used were found to be too small, the error having been due to the incorrectness of the old maps from which the data were compiled. The new measurement and the new division of the streets with reference to districts went into effect March 1, 1900, from which date the city and suburbs, including Casa Blanca and Regla, were divided into nine districts, instead of twelve as heretofore, the city districts being 1, 2, 3, and 4, instead of 1, 2, 3, 4, 5, 6, and 7, and the suburban districts 5, 6, 7, 8, and 9, instead of 8, 9, 10, 11, and 12.

The organization of the department of street cleaning, by months for the fiscal year ending June 30, 1900, is as follows:

| Months. | Super-intend-ency. | Office. | Inspect-ors. | Subin-spectors. | Foremen. | Laborers. | Water boys. | Average number employees per day, shown by months. |
|----------------|--------------------|---------|--------------|-----------------|----------|-----------|-------------|----------------------------------------------------|
| 1899. | | | | | | | | |
| July..... | 1 | 5 | 6 | 11 | 43 | 463 | 37 | 559 |
| August..... | 1 | 5 | 6 | 11 | 48 | 449 | 37 | 557 |
| September..... | 1 | 5 | 9 | 9 | 50 | 447 | 38 | 559 |
| October..... | 1 | 5 | 7 | 9 | 46 | 416 | 33 | 517 |
| November..... | 1 | 5 | 8 | 11 | 48 | 424 | 33 | 530 |
| December..... | 1 | 5 | 9 | 11 | 48 | 404 | 32 | 510 |
| 1900. | | | | | | | | |
| January..... | 1 | 5 | 6 | 8 | 45 | 357 | 28 | 450 |
| February..... | 1 | 5 | 7 | 6 | 43 | 356 | 30 | 448 |
| March..... | 1 | 5 | 5 | 6 | 47 | 404 | 39 | 507 |
| April..... | 1 | 5 | 5 | 6 | 43 | 400 | 29 | 489 |
| May..... | 1 | 5 | 4 | 10 | 46 | 414 | 31 | 511 |
| June..... | 1 | 5 | 5 | 10 | 46 | 441 | 34 | 542 |
| Average..... | 1 | 5 | 6 | 9 | 46 | 414 | 30 | 512 |

From July 1, 1899, to February 28, 1900, the wage paid to street sweepers was uniformly 84 cents per day. The desirability of inciting the individual to his best effort was held in view from the incipency of the work. It has not so far seemed advisable to institute the block system of assigning a quantity of street to each sweeper, but that system was applied to the cuadrillas or gang, and the result was so satisfactory that on March 1, 1900, the following scale of wages was adopted:

For laborers: First month, 84 cents per day; second month, 90 cents per day; third month, 95 cents per day; fourth month, \$1 per day, which is the maximum.

For water boys (all of whom are under 16 years of age): First month, 50 cents per day; second month, 55 cents per day; third month, 60 cents per day; fourth month, 65 cents per day; fifth month, 70 cents per day; sixth month, 75 cents per day, which is the maximum.

During the first six months of the period covered by this report 1,764 days of cart service were hired at prices ranging from \$4 to \$3 per day. In addition to the above, 10,031 days of cart service has been performed by carts and animals owned by the Department. A total of 73,431 cart loads, equivalent to 55,075 tons, of street refuse has been collected.

The amount and cost of street cleaning done are shown in the following tables, which show separately the work done under the old and new systems of districting.

Table showing unit costs of street cleaning.

EIGHT MONTHS ENDING FEBRUARY 28, 1900.

| District No. | Cleaned daily. | Sweepers employed, daily average number. | Average number square meters cleaned per man per day. | Cost per 1,000 square meters of cleaning. | | | | |
|--------------|-----------------------|------------------------------------------|-------------------------------------------------------|-------------------------------------------|----------|------------------|------------------|---------|
| | | | | Sweepers. | Carting. | Superintendence. | Office expenses. | Total. |
| | <i>Square meters.</i> | | | | | | | |
| 1 | 136,228 | 60 | 2,271 | \$0.37 | \$0.119 | \$0.068 | \$0.015 | \$0.572 |
| 2 | 103,472 | 42 | 2,464 | .34 | .113 | .065 | .014 | .532 |
| 3 | 289,011 | 72 | 4,014 | .21 | .069 | .039 | .009 | .327 |
| 4 | 108,897 | 34 | 3,203 | .26 | .082 | .047 | .010 | .399 |
| 5 | 232,273 | 32 | 7,259 | .12 | .039 | .022 | .005 | .186 |
| 6 | 226,152 | 48 | 4,712 | .18 | .060 | .034 | .008 | .282 |
| 7 | 90,803 | 38 | 2,390 | .35 | .120 | .088 | .015 | .573 |
| 8 | 199,209 | 39 | 5,108 | .16 | .047 | .026 | .007 | .240 |
| 9 | 214,122 | 38 | 5,635 | .15 | .045 | .024 | .006 | .225 |
| 10 | 82,093 | 23 | 3,569 | .24 | .072 | .039 | .010 | .361 |
| 11 | 112,036 | 22 | 5,093 | .16 | .049 | .027 | .007 | .243 |
| 12 | 14,000 | 25 | 560 | 1.50 | .450 | .244 | .064 | 2.258 |

MARCH 1, 1900, TO JUNE 30, 1900.

| | | | | | | | | |
|--|---------|----|-------|--------|---------|---------|---------|---------|
| | 281,949 | 87 | 3,246 | \$0.29 | \$0.048 | \$0.054 | \$0.016 | \$0.408 |
| | 282,993 | 67 | 4,277 | .23 | .043 | .039 | .012 | .324 |
| | 382,786 | 64 | 6,014 | .16 | .030 | .031 | .009 | .230 |
| | 280,752 | 50 | 5,609 | .17 | .035 | .049 | .015 | .269 |
| | 244,215 | 31 | 7,875 | .15 | .029 | .039 | .009 | .227 |
| | 359,625 | 60 | 6,032 | .16 | .025 | .037 | .009 | .231 |
| | 238,139 | 34 | 7,003 | .12 | .021 | .036 | .009 | .186 |
| | 22,093 | 26 | 2,158 | 1.13 | ----- | .177 | .052 | 1.359 |
| | 102,573 | 17 | 6,132 | .16 | .021 | .040 | .008 | .229 |

The conditions in old districts Nos. 7 and 12 (new district No. 8) were decidedly abnormal.

The cost of cleaning old district No. 7 was markedly increased by reason of its small size and the fact that it contained the city slaughter-house, from which the removal of the offal has constituted a part of the work of street cleaning.

In the Casa Blanca district (old No. 12, new No. 8) the conditions have been very difficult by reason of the absence of graded streets. Such of the refuse as could be so placed with safety has been used to bring the street spaces to a uniform surface. A riprap wall, 135 meters in length, has been built along the shore and a street constructed to facilitate the collection of refuse. In the autumn of 1899 a number of cases of yellow fever originated in this village, and from September to December, inclusive, a thorough and expensive general cleaning of the place was made. This work was not confined to the streets, but included private property as well. The whole place was thoroughly disinfected with electrozone, a number of decayed wharves were removed and the lumber burned, and not only the whole water front but the shallow portion of the bay near the shore were cleaned.

The expense of all this work, the cost of collecting garbage, and the disposal of all refuse as well, are included in the statement for this dis-

trict. This expense during the last four months has been distributed among the various classes of work as follows:

CASA BLANCA.

Distribution of expense from March 1 to June 30, 1900.

| | Percent- age. | Cost. |
|--------------------------------|------------------|----------|
| Collection of refuse | 20.7 | \$102.18 |
| Collection of night soil | 8.1 | 39.83 |
| Disposal..... | 12.8 | 62.93 |
| Repairs to streets | 12.8 | 62.93 |
| Street cleaning | 45.6 | 224.54 |
| Total..... | 100 | 492.41 |

REMOVAL OF REFUSE.

The average number of wheelbarrow loads and equivalent number of cart loads of street refuse, night soil, and filling removed from the streets of Casa Blanca for the months of May and June, 1900, are shown by the following table:

| | Wheel- barrow loads. | Equivalent cart loads. |
|---------------------|----------------------------|---------------------------|
| Street refuse | 2,443 | 162.8 |
| Night soil | 2,254 | 150.3 |
| Filling | 1,825 | 121.7 |
| Total..... | 6,522 | 434.8 |

During the months of May and June, 1900, electrozone was distributed at an average cost per month for distribution of \$67.75.

By reason of the amount of work other than street cleaning done in old districts Nos. 7 and 12 (new district No. 8), the average cost for the city per 1,000 square meters of street cleaning is not given in the preceding tables. Leaving these two districts out of consideration a fair average cost may be obtained.

The average cost of street cleaning per 1,000 square meters, for the fiscal year ending June 30, 1900, exclusive of districts (old numbers 7 and 12) is shown by the following table:

| | |
|-----------------------|---------|
| Sweeping | \$0.196 |
| Carting..... | .049 |
| Superintendence | .039 |
| Office expenses..... | .009 |
| Total | .293 |

NEIGHBORING VILLAGES.

All refuse from the streets and houses in the neighboring villages of Puentes Grandes, Ceiba, Arroyo Apolo, and Arroyo Naranjo is removed by means of wheelbarrows and push carts.

The average number of employees, square meters of streets cleaned, average number of square meters of cleaning per man per day, and

cost of cleaning 1,000 square meters, for the months of May and June, are shown by the following table:

| | Cleaned daily. | Average number sweepers employed daily. | Average number cleaned per man per day. | Cost of cleaning per 1,000 square meters. |
|---------------------------------------|--------------------|-----------------------------------------|-----------------------------------------|-------------------------------------------|
| | <i>Sq. meters.</i> | | <i>Sq. meters.</i> | |
| Puentes Grandes..... | 26,445 | 4 | 6,611 | \$0.15 |
| Ceiba | 23,430 | 4 | 5,857 | .17 |
| Arroyo Apolo and Arroyo Naranjo | 31,875 | 4 | 7,969 | .12 |

Arroyo Apolo and Arroyo Naranjo are cleaned by the same force and are reported as one village. A proper proportion of the expense would be one-third to Arroyo Apolo and two-thirds to Arroyo Naranjo.

The total number of cart loads of refuse of 1,500 pounds each, removed from the streets and houses during the months of May and June, are shown by the following table:

| | Street refuse. | Night soil. | House refuse. | Wheelbarrow loads. | Equivalent cart loads. |
|--------------------------------------|----------------|-------------|---------------|--------------------|------------------------|
| Puentes Grandes | 3,440 | 634 | 1,321 | 5,394 | 359 |
| Ceiba | 5,718 | 638 | 1,314 | 7,671 | 511 |
| Arroyo Apolo and Arroyo Naranjo..... | 7,345 | 598 | 1,368 | 9,311 | 621 |
| Total | 16,503 | 1,870 | 4,003 | 22,376 | 1,491 |

The distribution of expenditures in the neighboring villages for May and June, 1900, for street cleaning, collection, and disposal of street refuse, night soil, and house refuse, showing the percentage of total expenditures applied to each character of work, is shown by the following table:

| | Puentes Grandes | | | Ceiba, | | | Arroyo Apolo and Arroyo Naranjo. | | |
|--------------------|-------------------------|-------------|---------|-------------------------|-------------|---------|----------------------------------|-------------|----------|
| | Daily average laborers. | Percentage. | Cost. | Daily average laborers. | Percentage. | Cost. | Daily average laborers. | Percentage. | Cost. |
| Street refuse..... | 4 | 57.2 | \$99.75 | 4 | 57.3 | \$95.58 | 4 | 66.66 | \$105.00 |
| Night soil..... | 1 | 14.2 | 24.93 | 1 | 14.2 | 23.79 | 1 | 16.66 | 26.25 |
| House refuse | 2 | 28.6 | 49.88 | 2 | 28.5 | 47.67 | 1 | 16.66 | 26.25 |
| Total | 7 | 100 | 174.56 | 7 | 100 | 167.04 | 6 | 100 | 157.50 |

The work and the cost of the street cleaning, disposal and removal of refuse in the village of Luyano are included in the street cleaning of the seventh district.

The area cleaned is about 20,000 square meters, and the total cost of cleaning, collection, and disposal of refuse per day is \$6, of which sum \$4 is devoted to street cleaning, \$1 to collection of house refuse and \$1 to disposal of refuse.

On February 1, 1900, the experiment of sweeping the streets at night was begun in the eastern half of districts Nos. 1 and 2. This was undertaken on account of the excessively heavy traffic in the narrow streets of this locality during the day, and the consequent utter

impossibility of doing the work properly and at a reasonable cost. In addition to this it was believed that the men and animals employed in the service could endure the hardships of the work much better. By April 1 the experiment had proven so satisfactory that it was decided to include in the night cleaning the entire area of the city lying east of and including Egido and Monserrate streets, and now designated as district No. 1. This change has reduced the number of men and carts employed, and has, in addition to this, reduced the cost of the collection of house refuse, inasmuch as it is collected by the teams of that subdepartment immediately in advance of the street-cleaning gangs. This area, where necessity requires, is cleaned during the day by a small force of men provided with push carts and garbage cans, who pick up such materials as are scattered over the streets during the working hours of the day.

Climatic conditions have necessitated great care in the work of street cleaning, and at all times attention has been paid to the condition of the back streets as well as to streets of commercial importance, so that all should be kept uniformly clean.

The labor employed in this work is well organized and has given faithful service. It has been very difficult to arouse interest in the force in the cleanliness of their uniforms, which are of white drill, but considerable progress has been made in that direction. These uniforms as well as shoes and hats are purchased by the department in quantity and sold to the sweepers at cost. The suit costs, \$1.10; shoes, \$1.13; hat, \$1.10; total, \$3.33.

STREET SPRINKLING.

This was carried on as a part of the work of street cleaning. The large amount of macadam pavement and the importance of frequent sprinkling of new macadam, together with the well-recognized danger of dust-laden breezes, have necessitated considerable attention and expenditure in this service.

Thirteen sprinkling wagons of the Austin and Studebaker types, varying in capacity from 500 to 750 gallons each, have been employed. The working parts of 9 of these machines were specially constructed to permit of their use in the distribution of electrozone when necessary. They are drawn by two, three, or four mules, as the character of the routes upon which they are employed may demand, and managed by a driver and assistant.

A satisfactory organization of this service was not obtained until January 1, 1900, when it was placed under the charge of Mr. Fred W. Steinbuch, as superintendent.

Since, and including December, 1899, the streets of the old city to the east of and including Cuba street have been sprinkled with electrozone. In addition to this service, each of the 12 street-cleaning districts, excepting the districts embracing Regla and Casa Blanca, was provided with a barrel of 100 gallons capacity, mounted upon wheels, and this, filled with electrozone, was used daily in each district, in the disinfection of sewers, gutters, vacant lots, and wherever decomposed vegetation and animal matter were found. In many instances electrozone has been furnished to private families for interior disinfection.

Orders have been placed for three sprinkling wagons, each of 750 gallons capacity, and 25 mules have been purchased for use in this service, in addition to those now in use.

Sea water has been used in some instances, and its efficiency in keeping down dust has been decidedly greater than that of fresh water. The establishment of stations along the coast and on the bay shore, for loading sprinklers with salt water, is now under way.

The following table gives the general data as to street sprinkling with water, and the distribution of electrozone in connection with the work of street sweeping:

Daily average, July 1, 1899, to June 30, 1900.

| | |
|------------------------------------------------------------------|------------------------|
| Force employed: | |
| Inspectors | 2 |
| Drivers | 11 |
| Assistant drivers | 10 |
| Mules | 27 |
| Wagons | 8 |
| Daily average | square meters 739, 331 |
| Total per month | do. 23, 082, 075 |
| Daily average | linear miles 73. 31 |
| Total per month | do. 2, 332. 4 |
| Gallons of water used daily | 106, 669 |
| Costs: | |
| Sprinkling— | |
| Per 1,000 square meters | \$0. 0095 |
| Per linear mile | \$0. 8825 |
| Per 1,000 gallons | \$0. 571 |
| Per day | \$62. 49 |
| Distribution of electrozone September 1, 1899, to June 30, 1900: | |
| Total number of gallons distributed | 1, 027, 584 |
| Average number of gallons distributed daily | 3, 423 |
| Cost: | |
| Average cost per 1,000 gallons | \$3. 54 |
| Average cost per day | \$12. 06 |

COLLECTION OF REFUSE.

[Mr. J. M. Izquierdo, superintendent, July 1 to September 21, 1899; Mr. T. F. Maher, superintendent September 21, 1899, to June 30, 1900.]

This subdepartment comprises the collection of garbage of the entire city of Habana.

At the beginning of the present fiscal year both the animals and the rolling stock used in connection with this work were in a very bad condition, the animals being overworked and underfed and the vehicles in a bad state of repair, and, in a number of cases, totally worthless. With the prospect of a greatly increased volume of work and a small amount of funds with which to make improvements upon the plant, the outlook was anything but encouraging. The character of the harness was modified, so as to lessen the number of sore backs and shoulders. The repair of the rolling stock and improvement of the condition of the animals by better feed and care generally were taken up, which resulted in a great improvement in the service, one of the important factors being the substitution of American for Cuban hay.

Toward the end of the month of September this work was placed under the direct supervision of Mr. T. F. Maher, the present superintendent, and a decided general improvement has been shown from that time, in the condition of the plant, the amount of work done, and the unit cost.

In September 10 sanitary carts, built of iron, with hinged covers provided with rubber gaskets, with a capacity of 65 cubic feet each, were added to this service for use in the vicinity of hotels, wholesale groceries, and in the collection of slaughterhouse offal.

In September a house-to-house inspection and cleaning was begun by the sanitary department of the city, and the condemned furniture and rubbish taken from the private premises were placed in the streets for removal by the engineer department, necessitating a large increase in the force. The expense of removing refuse of this character has been \$11,852.53 since September, 1899.

The work of removal of refuse has been gradually systematized and the cost reduced.

The principal data relative to this work are shown in the following table:

Collection of refuse, July 1, 1899, to June 30, 1900.

| Month. | Men. | Animals. | | | | | | | | | Carts. | |
|----------------|------|----------|--------|--------|------|--------|------|----------------|--------|------|---------|---------|
| | | Riding. | | Cart. | | Snaps. | | Unserviceable. | | | Single. | Double. |
| | | Horses. | Mules. | Mules. | Oxen | Mules. | Oxen | Horses. | Mules. | Oxen | | |
| 1899. | | | | | | | | | | | | |
| July..... | 292 | 13 | ----- | 106 | 10 | 4 | 8 | 3 | 32 | 8 | 60 | 27 |
| August..... | 326 | 12 | ----- | 110 | 8 | 4 | 8 | 3 | 40 | 8 | 64 | 27 |
| September..... | 314 | 13 | 2 | 105 | 10 | 4 | 8 | 3 | 40 | 7 | 61 | 27 |
| October..... | 418 | 13 | 5 | 125 | 14 | 2 | 8 | 3 | 34 | 7 | 83 | 28 |
| November..... | 454 | 17 | 8 | 111 | 14 | 2 | 6 | 4 | 31 | 8 | 67 | 29 |
| December..... | 436 | 16 | 8 | 129 | 20 | ----- | 6 | 4 | 21 | 7 | 91 | 29 |
| 1900. | | | | | | | | | | | | |
| January..... | 399 | 16 | 8 | 119 | 20 | ----- | 4 | 4 | 27 | 7 | 81 | 29 |
| February..... | 386 | 15 | 8 | 115 | 20 | 2 | 2 | 4 | 31 | 7 | 77 | 29 |
| March..... | 395 | 13 | 9 | 115 | 20 | ----- | 1 | 4 | 29 | 7 | 77 | 29 |
| April..... | 384 | 13 | 10 | 112 | 20 | ----- | 1 | 4 | 27 | 7 | 74 | 29 |
| May..... | 358 | 12 | 16 | 104 | 20 | 1 | 2 | 4 | 15 | 5 | 66 | 29 |
| June..... | 363 | 12 | 16 | 103 | 20 | 1 | 2 | 4 | 17 | 5 | 65 | 29 |
| Average.. | 378 | 14 | 8 | 113 | 16 | 2 | 5 | 4 | 29 | 7 | 72 | 28 |

| Month. | Work performed. | | | | | Cost. | | |
|----------------|-----------------------|-----------------------|---------------|-----------------------|----------------|------------------|----------|-------------|
| | Houses visited daily. | Tons per house daily. | Tons per day. | Total tons collected. | Miles per ton. | Per house daily. | Per ton. | Total. |
| 1899. | | | | | | | | |
| July..... | 17,440 | .011 | 191 | 5,925 | 3.6 | \$0.28 | \$2.56 | \$15,184.74 |
| August..... | 17,721 | .0115 | 205 | 6,355 | 3.6 | .03 | 2.61 | 16,606.84 |
| September..... | 18,120 | .0149 | 272 | 8,160 | 3.6 | .031 | 2.27 | 18,500.07 |
| October..... | 19,123 | .016 | 306 | 9,479 | 3.6 | .033 | 2.07 | 19,663.88 |
| November..... | 19,023 | .0142 | 267 | 8,082 | 3.6 | .034 | 2.42 | 19,577.13 |
| December..... | 19,182 | .0143 | 273 | 8,430 | 3.6 | .025 | 2.08 | 17,557.60 |
| 1900. | | | | | | | | |
| January..... | 21,183 | .0127 | 269 | 8,337 | 3.6 | .025 | 1.95 | 16,313.30 |
| February..... | 21,607 | .0101 | 242 | 6,767 | 3.6 | .022 | 1.95 | 13,202.87 |
| March..... | 21,641 | .0113 | 244 | 7,554 | 3.6 | .025 | 2.19 | 16,596.27 |
| April..... | 21,641 | .012 | 274 | 8,042 | 3.6 | .025 | 2.02 | 16,240.40 |
| May..... | 21,419 | .013 | 271 | 8,383 | 3.6 | .025 | 1.93 | 16,204.31 |
| June..... | 21,415 | .012 | 270 | 8,104 | 3.6 | .022 | 1.90 | 15,434.34 |
| Average.. | 19,960 | .0127 | 258 | 7,802 | 3.6 | .027 | 2.16 | 16,756.81 |

The high rate of cost during the months of July, August, September, and November is due to the extension of the work over new areas in the suburban districts, where the roads were uniformly bad and the people unaccustomed to the service.

The expenditures on account of removing material from disinfected houses, which are included in the preceding table, are shown by months below:

1899:

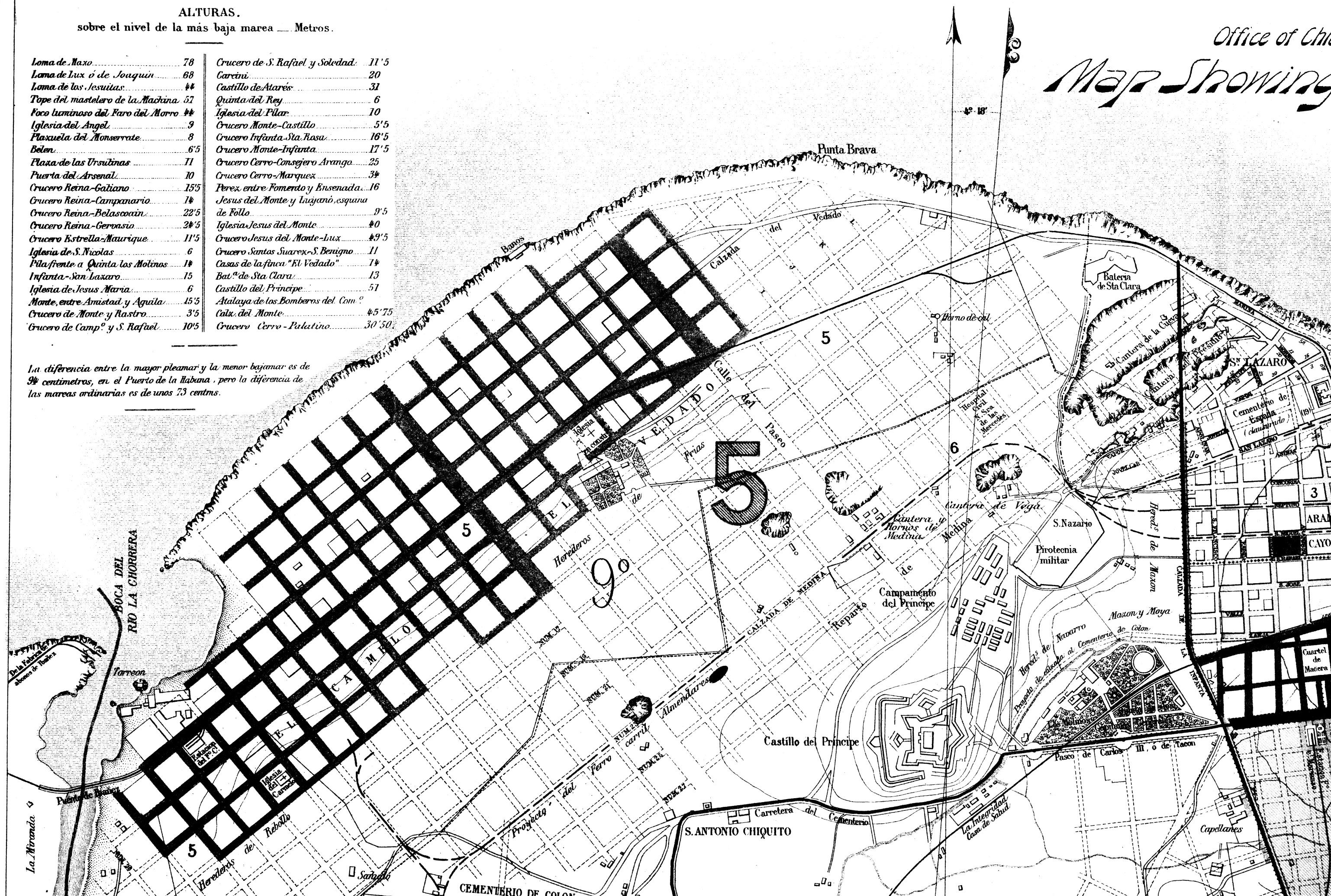
| | |
|----------------|------------|
| October | \$2,286.40 |
| November | 2,098.00 |
| December | 1,924.75 |

ALTURAS.
sobre el nivel de la más baja marea — Metros.

| | | | |
|---------------------------------------|------|---------------------------------------|-------|
| Loma de Moxo..... | 78 | Crucero de S. Rafael y Soledad..... | 11'5 |
| Loma de Lux ó de Joaquín..... | 68 | Carretera..... | 20 |
| Loma de las Jesuitas..... | 44 | Castillo de Atarés..... | 31 |
| Tope del mastelero de la Máquina..... | 52 | Quinta del Rey..... | 6 |
| Foco luminoso del Faro del Morro..... | 44 | Iglesia del Pilar..... | 10 |
| Iglesia del Angel..... | 9 | Crucero Monte-Castillo..... | 5'5 |
| Plazuela del Monserrate..... | 8 | Crucero Infanta Sta. Rosa..... | 16'5 |
| Belen..... | 6'5 | Crucero Monte-Infanta..... | 17'5 |
| Plaza de las Ursulinas..... | 11 | Crucero Cerro-Consuegro Arango..... | 25 |
| Puerta del Arsenal..... | 10 | Crucero Cerro-Marquez..... | 34 |
| Crucero Reina-Galiano..... | 15'5 | Perez entre Fomento y Ensenada..... | 16 |
| Crucero Reina-Campanario..... | 14 | Jesus del Monte y Lujaño, esquina | |
| Crucero Reina-Belascosain..... | 22'5 | de Folio..... | 9'5 |
| Crucero Reina-Gervasio..... | 24'5 | Iglesia Jesus del Monte..... | 40 |
| Crucero Estrella-Maurique..... | 11'5 | Crucero Jesus del Monte-Lux..... | 49'5 |
| Iglesia de S. Nicolas..... | 6 | Crucero Santos Suarez-S. Benigno..... | 11 |
| Pila frente a Quinta los Molinos..... | 14 | Casas de la finca "El Vedado"..... | 14 |
| Infanta-San Lazaro..... | 15 | Bat.ª de Sta. Clara..... | 13 |
| Iglesia de Jesus Maria..... | 6 | Castillo del Principe..... | 51 |
| Monte, entre Amistad y Aguila..... | 15'5 | Atalaya de los Bomberos del Com.º | |
| Crucero de Monte y Rastro..... | 3'5 | Calx. del Monte..... | 45'75 |
| Crucero de Camp.º y S. Rafael..... | 10'5 | Crucero Cerro-Palutino..... | 30'50 |

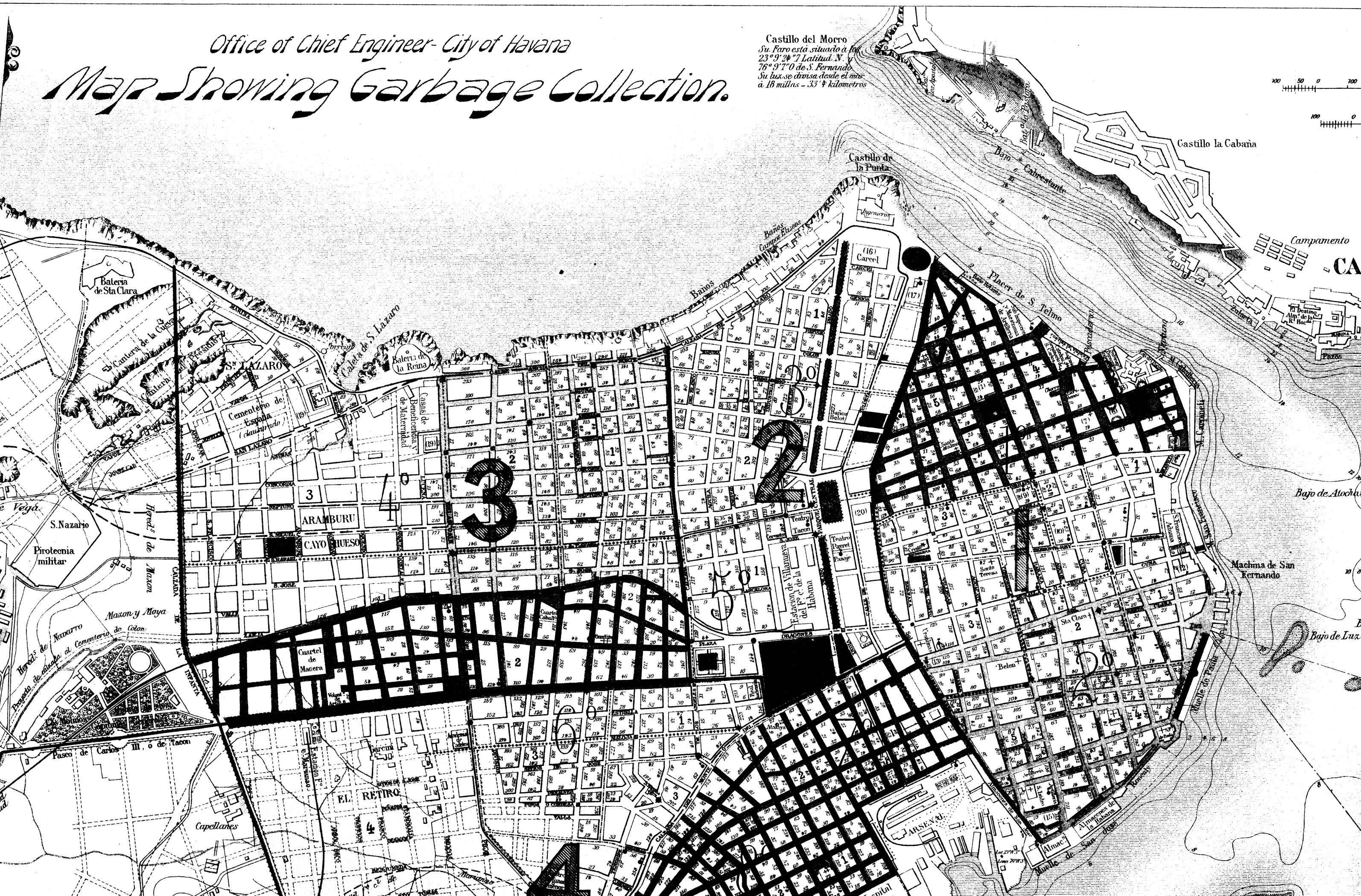
La diferencia entre la mayor pleamar y la menor bajamar es de 94 centímetros, en el Puerto de la Habana, pero la diferencia de las mareas ordinarias es de unos 73 centms.

Office of Charts
Map Showing

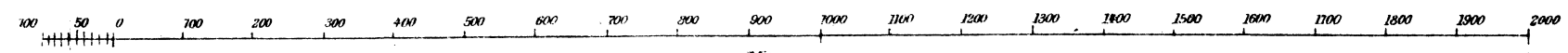


Office of Chief Engineer- City of Havana
Map Showing Garbage Collection.

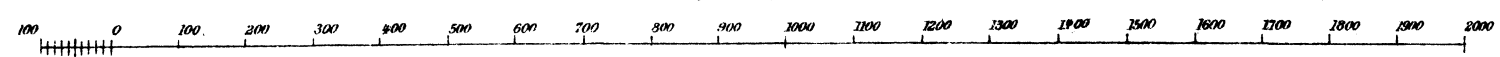
Castillo del Morro
*Su Faro está situado a lat.
 23° 9' 24" 17 Latitud N. y
 76° 9' 17" 0 de S. Fernando
 Su luz se divisa desde el mar
 a 18 millas = 33 1/2 kilometros*



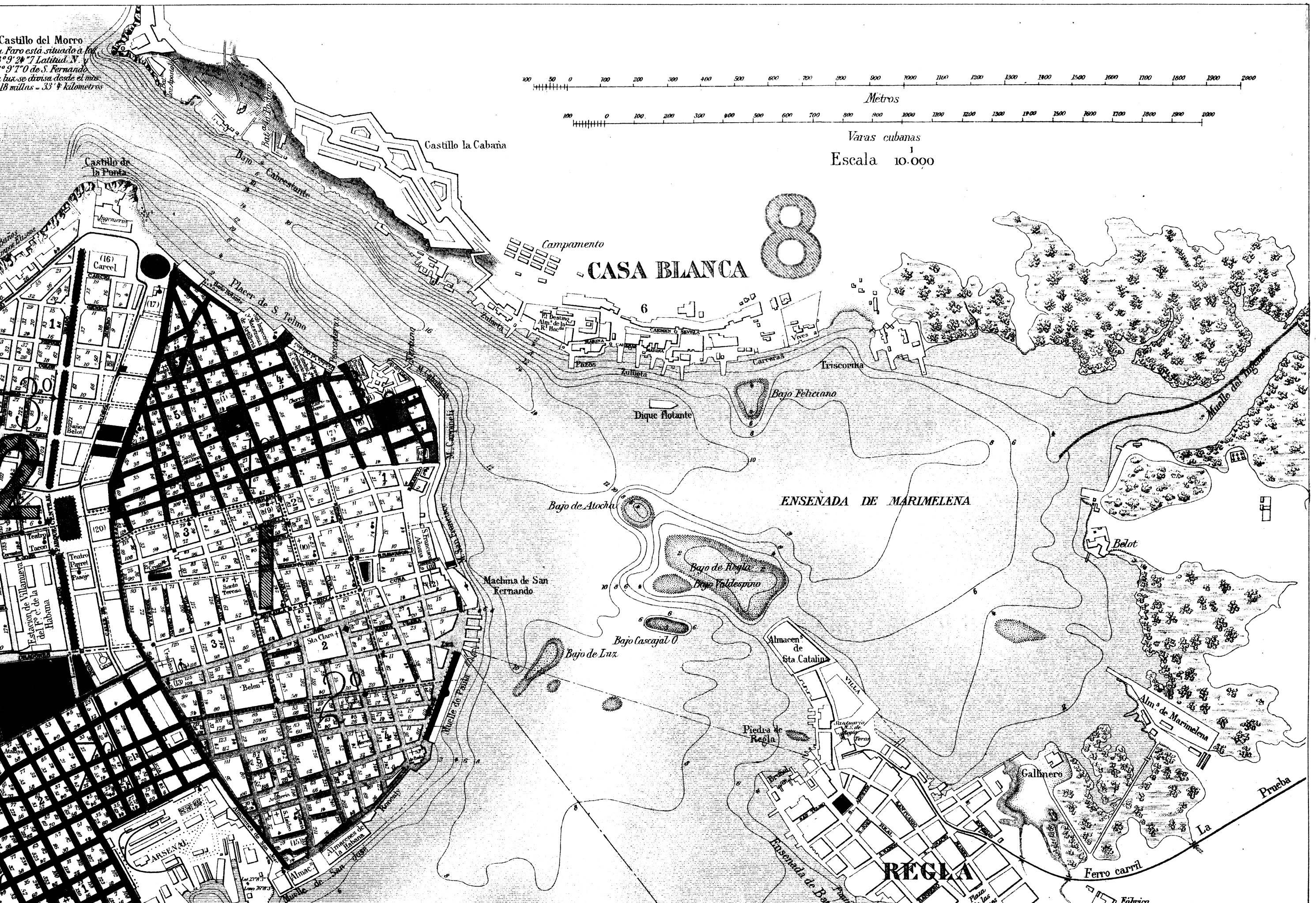
Castillo del Morro
Faro está situado a las
9° 24' 7" Latitud N.
9° 7' 0" de S. Fernando
buz. se divide desde el mar
18 millas = 33 1/2 kilometros



Metros



Varas cubanas
Escala 10.000



Castillo la Cabaña

Campanento

CASA BLANCA

8

ENSENADA DE MARIMELENA

REGLA

Prueba

Ferro carril

Gallinero

Piedra de Regla

Almacén de Sta Catalina

Machina de San Fernando

Bajo de Lux

Bajo Cascayal O

Bajo de Regla
Bajo Valdespino

Dique flotante

Bajo Fehciano

Triscomina

Carreteras

Pazos

Zaligeta

Bajo de Atocha

Plaza de S. Telmo

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HABANA

DE LA

D. ESTEBAN T. PICHARDO,

AGRIMENSOR Y MAESTRO DE OBRAS.

EDITOR: D. JOSÉ VALDEPARES.

Para la formación de este Plano, se han tenido presentes: el publicado por el Excmo. Ayuntamiento, el del Puerto por los Ingenieros de Obras publicas, y otros debidos a los Sres. D. Mariano Carles, D. José Ocampo, D. J. Manuel Alvaro, D. Alberto de Castro, D. Antonio Ariza, D. José Lopez Trigo, D. José C. del Castillo, D. Simon Teja & ; cuyos trabajos ha combinado el Autor del presente, añadiendo los que practico expofeso sobre el terreno.

*Las curvas de igual sonda, dibujadas en el Puerto, indican la profundidad del agua de dos en dos metros, en
baja mar, y están deducidas del sondeo verificado por O. públicas en 1874.*

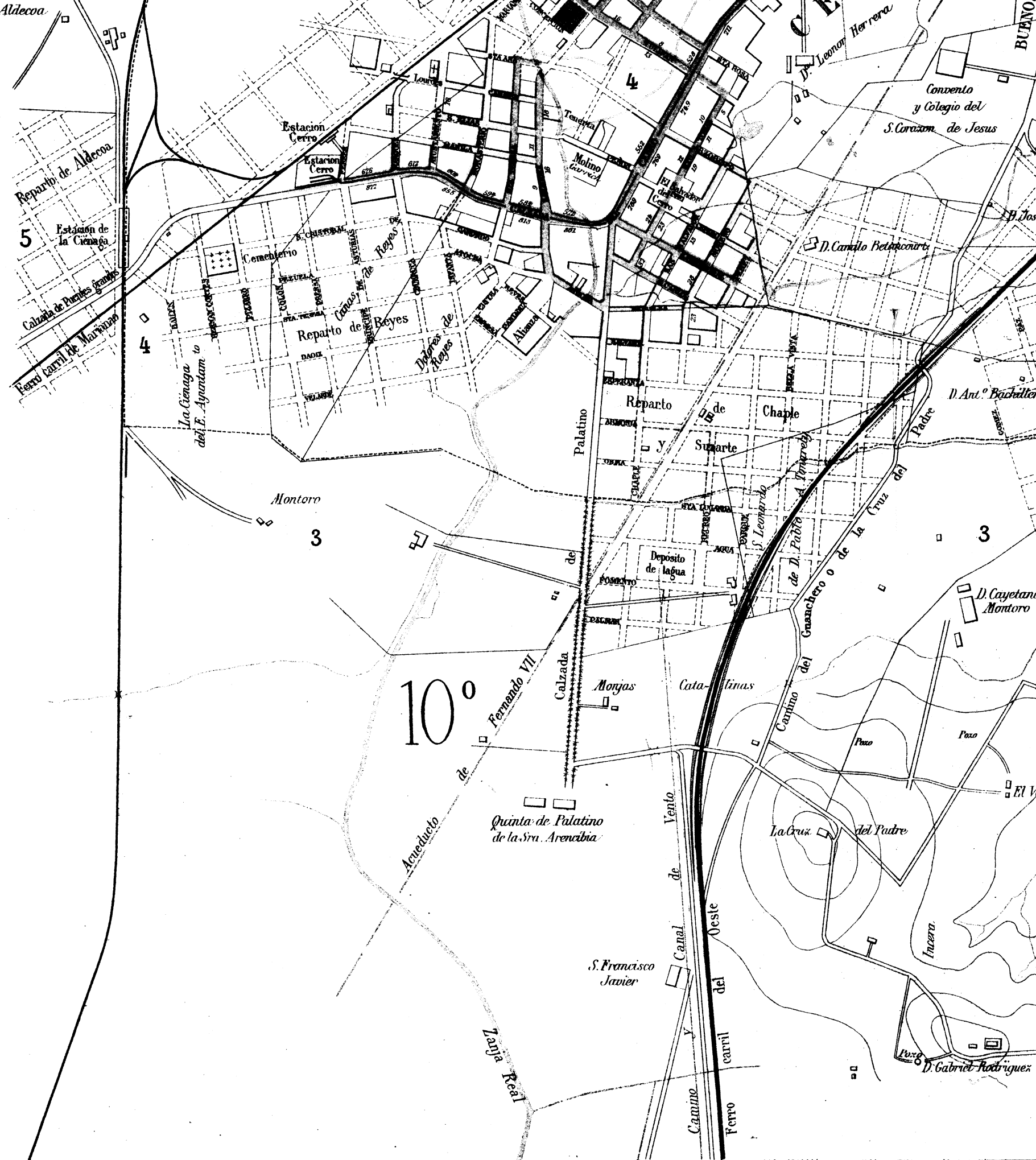
- | | | |
|---------|----------------------------------|------------------------|
| ● | Estac. ^{ta} telegrafica | } Servicio de Bomberos |
| ■ | Caja de agua | |
| ◆ | Caja y sifon | |
| ● | Sifon | |
| <hr/> | | |
| | Ferro carril en explotacion | |
| <hr/> | | |
| ---- | Idem en proyecto | |
| <hr/> | | |
| † | Parroquia | |
| <hr/> | | |
| - - - - | Limite Municipal | |
| <hr/> | | |
| .. | Idem de Distrito municipal | |
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| ----- | Idem de Barrio | |
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| +++++ | Idem de Parroquia | |

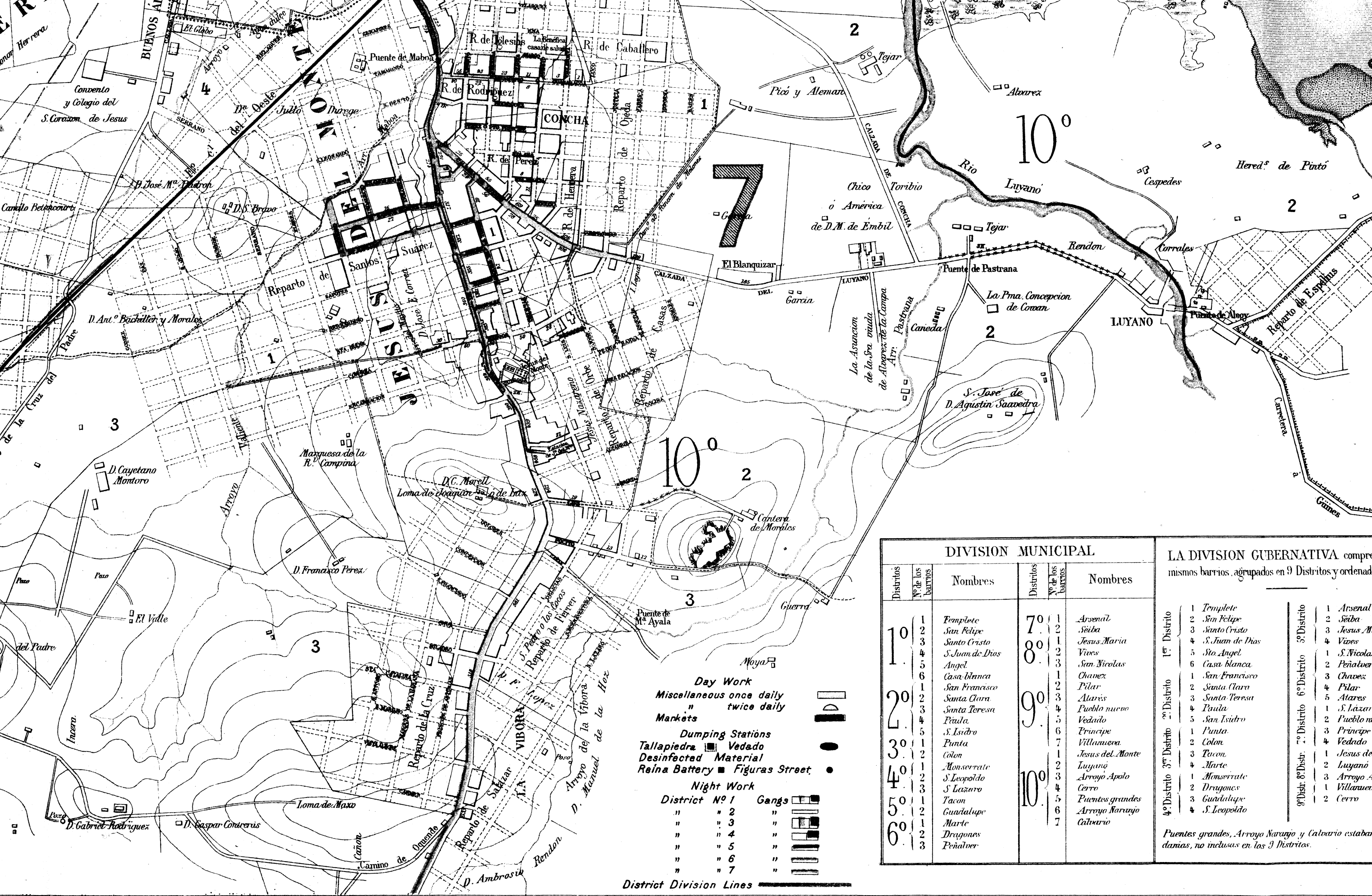
Los números de las casas corresponden al último de cada frente de manzana y están escritos en carácter itálico, como 1, 2, 3, 4

Los que se refieren à la numeracion del Directorio, estan escritas en carácter romano, y entre parentesis: (1)(2)(3)(4)

Las ordinales de los Distritos municipales son de caracter capitales y tamaño grande: 1º

Los de los barrios son de carácter romano, mayores que los del Directorio: 1, 2, 3





DIVISION MUNICIPAL

| Distritos | Nº de los barrios | Nombres | Distritos | Nº de los barrios | Nombres |
|-----------|-------------------|-----------------|-----------|-------------------|-----------------|
| 1º | 1 | Templete | 7º | 1 | Arsenal |
| | 2 | San Felipe | | 2 | Seiba |
| | 3 | Santo Cristo | | 3 | Jesus Maria |
| | 4 | S. Juan de Dios | 8º | 1 | Vivos |
| | 5 | Angel | | 2 | San Nicolas |
| | 6 | Casa blanca | | 3 | Chavez |
| | 7 | San Francisco | | 4 | Pilar |
| 2º | 1 | Santa Clara | | 5 | Alarès |
| | 2 | Santa Teresa | 9º | 3 | Pueblo nuevo |
| | 3 | Paula | | 4 | Vedado |
| | 4 | S. Isidro | | 5 | Principe |
| | 5 | Punta | | 6 | Villanueva |
| 3º | 1 | Colon | | 7 | Jesus del Monte |
| | 2 | Monserate | | 8 | Luyano |
| 4º | 1 | S. Leopoldo | | 9 | Arroyo Apolo |
| | 2 | S. Lazaro | | 10 | Cerro |
| 5º | 1 | Tacon | | 11 | Puentes grandes |
| | 2 | Guadalupe | | 12 | Arroyo Narayño |
| 6º | 1 | Marte | | 13 | Caltuario |
| | 2 | Dragones | | | |
| | 3 | Peñalver | | | |

LA DIVISION GUBERNATIVA comprende los mismos barrios, agrupados en 9 Distritos y ordenados en 9 Distritos

| | | | | | |
|-------------|---|-----------------|-------------|---|-----------------|
| 1º Distrito | 1 | Templete | 5º Distrito | 1 | Arsenal |
| | 2 | San Felipe | | 2 | Seiba |
| | 3 | Santo Cristo | | 3 | Jesus Maria |
| | 4 | S. Juan de Dios | | 4 | Vivos |
| | 5 | Sto. Angel | 6º Distrito | 1 | S. Nicolas |
| | 6 | Casa blanca | | 2 | Penalver |
| | 7 | San Francisco | | 3 | Chavez |
| 2º Distrito | 1 | Santa Clara | | 4 | Pilar |
| | 2 | Santa Teresa | | 5 | Alarès |
| | 3 | Paula | 7º Distrito | 1 | S. Lazaro |
| | 4 | San Isidro | | 2 | Pueblo nuevo |
| | 5 | Punta | | 3 | Principe |
| 3º Distrito | 1 | Colon | | 4 | Vedado |
| | 2 | Tacon | 8º Distr. | 1 | Jesus del Monte |
| | 3 | Marte | | 2 | Luyano |
| | 4 | Monserate | | 3 | Arroyo Apolo |
| | 5 | Dragones | | 4 | Villanueva |
| 4º Distrito | 1 | Guadalupe | 9º Distr. | 1 | Cerro |
| | 2 | S. Leopoldo | | | |

Puentes grandes, Arroyo Narayño y Caltuario estaban en las 9 distritos, no incluidas en los 9 distritos.

| | |
|----------------|------------|
| 1900: | |
| January | \$1,681.46 |
| February | 648.78 |
| March | 759.25 |
| April | 865.25 |
| May | 836.32 |
| June | 752.32 |
| Total | 11,852.53 |

DISPOSAL OF REFUGE.

[Mr. J. L. Mudge, superintendent in charge.]

During the first six months of 1899 all refuse was carried to sea on flat decked scows. During the fiscal year the same method, in conjunction with a crematory, has been employed.

At the beginning of the year 1899 the site selected upon which to construct the buildings for use in connection with this work, immediately in the rear of the old Spanish military hospital, and extending along the water front for 61 meters, with a depth of 116 meters, was covered in part by old, worthless buildings. The grade was low, filled with mud holes, and in a very unsanitary condition. The worst of the buildings were demolished and the woodwork burned, the stone disinfected and piled up for future use. The grounds were thoroughly cleaned and disinfected, sewers and drains laid, and the lower portion built up to a grade which would permit of its use for the purpose intended temporarily. About 6,000 loads of broken stone, street excavations, gravel, and cinders were used in this filling. The Davis crematory, the construction of which was begun in March, 1899, was completed and accepted. Certain modifications, necessary for the cremation of the peculiar character of refuse in Habana, were made by the builders.

A coal bin, having a storage capacity of about 2,000 tons, was built immediately in the rear of the crematory. A blacksmith repair shop, for general repair work, a stable for the animals used as "snaps," a bath house for the use of employees, a wash basin in which the carts and wagons are cleaned and disinfected, and two storerooms have been built. A concrete floor has been laid in front of the furnaces, 22 meters long by 4 meters wide. Two masonry drains, about 30 meters each in length, have been laid to carry the surface water from the yard to the Factoria Street sewer. The dump has been improved by the erection of a roof for protection of the workmen engaged in stowing the material on the scows. An entirely new dumping board for use in connection with the disposal of night soil, matadero offal, and all other liquid or semiliquid refuse has been constructed. A building two stories high, 16 feet by 32 feet in plan, has been built, in which are located the offices of the superintendent. A considerable portion of the labor necessary for the execution of these improvements was performed by the regular employees of the dumping crews at times when their services were not otherwise needed.

During January and February the dumping board was extended by an addition of 6.1 meters to its east end. A dirt road and wooden approach were built from this addition to the south end of Factoria street, a distance of 64 meters, at a cost of about \$1,000. This

approach reduces the grade to the dump by one-half, and also shortens the distance from the foot of Factoria street to the dumping board.

The space under the wooden portion of this improvement is utilized as stable room for the animals and vehicles used in connection with this work. The work of building these stalls was done by the regularly employed force at such time as their services were not otherwise needed and from materials on hand.

During the month of October, 1899, a contract was entered into between the engineer department and the Merrill-Stevens Engineering Company, of Jacksonville, Fla., for the construction and delivery at Habana, Cuba, of 3 wooden decked scows, 100 feet long, 27 feet wide, and 8 feet deep, for the sum of \$10,000. These scows were constructed upon specifications drawn up by the department, and the details of the work superintended by an inspector employed by the department. They were delivered in Habana about January 1, 1900, in good condition.

At least one large dumping scow is much needed for the transportation to sea of night soil and refuse of similar character. During the year one of the scows belonging to "works of the port" has been used in this service, but it is in a bad state of repair, is too small, and is needed in connection with dredging operations.

The tug *Narciso Deulofeu* has been used throughout the year in towing barges to sea, and has given very satisfactory service. The hull plates of this vessel will probably require some patching during the coming year, and the installation of a new boiler would be advisable.

The sanitary conditions at the dock are very satisfactory and the health of the employees most excellent. During the past ten months about thirty-five thousand days' work has been done, and not a death from sickness nor a serious case of illness has occurred. A majority of the employees are sober, frugal, industrious, hard-working men. Many of them have been in their present positions several months and some of them more than a year.

The following tabular statement is a summary of the work done:

Disposal of refuse July 1, 1899, to July 1, 1900.

| Character of refuse. | Loads. | Tons. |
|------------------------------|----------|----------|
| House and street refuse..... | 173, 191 | 103, 301 |
| Slaughterhouse offal..... | 3, 063 | 2, 310 |
| Night soil..... | 27, 747 | 17, 124 |
| Sewer dirt..... | 9, 079 | 5, 476 |
| Cinders..... | 8, 692 | 5, 284 |
| Total..... | 221, 772 | 133, 495 |
| Average per month..... | 18, 481 | 11, 125 |

| | |
|-------------------------------|-----------------------------------|
| Method of disposal: | Cost of disposal: |
| Cremation.....per cent.. 11.2 | Cremation, per ton..... \$1.14 |
| Removal to sea.....do.. 84.8 | Removal to sea, per ton..... .425 |
| Filling in yard.....do.. 4.0 | Filling in yard..... .10 |

CREMATION.

The enormous consumption of coal in order to cremate carcasses and keep a fire suitable for that purpose continually, resulted in the decision about the 1st of April to raise one of the stacks as an experi-

ment, 30 feet being the additional length estimated as being necessary to create proper draft.

The work was completed on April 15, and the consumption of coal was decreased within ten days from 8 to $2\frac{1}{2}$ per cent. During the second ten-day period the percentage of coal was reduced from $2\frac{1}{2}$ to $2\frac{1}{4}$ per cent. This proportion between the coal consumed and weight of refuse destroyed has continued up to the present time.

On June 20 contract was entered into with Mr. Rafael Villasuso for a similar addition of 30 feet to the other smokestack and some slight repairs to the chimney base, the work to be completed during the fiscal year.

On June 26 an experiment was made with a single furnace, having the entire draft of the smokestack, for the purpose of determining whether or not a fire of sufficient intensity could be maintained throughout ten hours without the use of any coal. The material used in this experiment, broken boxes, barrel staves, paper, straw, palm leaves, tobacco stems, etc., was taken from the delivery that day, without additional cost for the picking. The experiment was entirely satisfactory, and it is believed that the future consumption of coal will be exceedingly small except in the cremation of large animals.

CARE AND PRESERVATION OF PARKS.

[Mr. A. C. Harper, superintendent, July 1 to December 31, 1899; Mr. J. C. Mehan, superintendent, January 1 to July 1, 1900.]

There has been a marked improvement in the general appearance of the parks and it is believed that the changes made have been gratifying to the people of the city.

COLON PARK

This park, containing 45,000 square meters, was, at the beginning of 1899, virtually a flower and vegetable garden. Diagonal walks, connecting its four corners, were used purely as thoroughfares. Women and children were seldom seen within its limits. All space other than the walks was fenced in and planted with roses and vegetables, many of which were sold by the gardeners, who pocketed the proceeds.

The fences have been almost entirely removed; low hedges of dwarf foliage plants have been set; the walks have been repaired; the margins, and to some extent the interiors, of the beds have been sodded; the service pipes of the fountains and hydrants have been renewed; the number of benches has been largely increased (200 new benches have been distributed among the parks of the city), and the roses removed have been transplanted to a portion of the Aldecoa (city) farm, which has been set aside as a rose garden. Separate closets for men and women have been installed in an existing structure, and the building suitably screened with vines.

SPECIAL WORK.

The Prado Promenade from Neptuno street to the north end and the pavements of Central, Paula, Cristo, Albear, and Jesus Maria parks

and the Promenade Isabel la Catolica have been repaired. The area of this work is 3,900 square meters; the average cost 25 cents per square meter. Rotten cementitious limestone, known as "cocoa," and sand, were the materials used in these pavements.

One hundred and fifty-three shade trees were planted on the Calzada de la Infanta extension, at a cost of \$2.50 per tree for carting, setting out, and boxing.

Since the beginning of the present calendar year the labor necessary for the cultivation of flowers has been largely reduced, by reason of the increased sodded area.

The average force employed in the preservation of parks has been 79 men, divided as follows:

| | | | |
|----------------------|---|-----------------|----|
| Chief gardener | 1 | Gardeners | 12 |
| Subinspector | 1 | Laborers | 61 |
| Timekeeper | 1 | | |
| Florist | 1 | Total | 79 |
| Foremen | 2 | | |

During the months of May and June the following special work has been done:

PUNTA PARK.

The iron and masonry fence, and inclosed masses of shrubs, have been partly removed and replaced by sodded area and small shrubbery beds. The walks have been resurfaced with cocoa and sand and a neat concrete curb placed around a sodded area. Some seats have been added and all old ones put in repair. The iron fence around the Neptune statue has been removed and the fountain cleaned and painted.

NORTH END OF PRADO.

The Prado has been extended across San Lazaro street, along the west side of Castillo de la Punta, with the same double roadway, the center space planted with grass and walks graded. The circular bed at the end is designed to connect with a drive, which it is hoped will be built along the water front in the near future. A water supply has been put in and a surface-water sewer built.

TULIPAN PARK.

This park has been partially remodeled and wholly repaired. This work was made necessary by the repairs made by the street department on the streets surrounding the park.

INDIA PARK.

The work of improvement of India Park has been started and will be pushed to an early completion. The work contemplated is to change the park from a mere thoroughfare to a resting place for the public, with a sodded playground for small children. This scheme, with the beautiful Indian statue as a centerpiece, should make this one of the most popular parks in the city.

VEDADO PRADO.

One square of this park has been improved, the work consisting of widening the grass space on either side and raising the center enough for drainage, installing water pipe and putting in two shrubbery beds. It is the intention of the people living in that vicinity to build a band stand, around which shrubs will be placed.

The following is an itemized account of the average work done each month:

| | | |
|---------------------------------------|-----------------|-------------|
| Area cleaned..... | square meters.. | 4, 109, 606 |
| Area watered..... | do..... | 2, 430, 245 |
| Area graded..... | do..... | 6, 087 |
| Area grass planted..... | do..... | 803 |
| Area grass weeded..... | do..... | 3, 265 |
| Number trees transplanted..... | | 30 |
| Number plants transplanted..... | | 558 |
| Number plants grafted..... | | 250 |
| Number cleanings of fountains..... | | 403 |
| Number cart loads refuse removed..... | | 275 |
| Number potted plants attended to..... | | 15, 670 |

The park work has required 1,421 days of cart service in the moving of 6,792 tons of material.

The average amount per month of the various kinds of work done during the last six months is as follows:

| | | |
|------------------------------------|-----------------|-------------|
| Grading..... | square meters.. | 1, 891 |
| Raking..... | do..... | 1, 060 |
| Hoeing..... | do..... | 1, 859 |
| Spading..... | do..... | 2, 174 |
| Grass cutting..... | do..... | 4, 158 |
| Cleaning..... | do..... | 3, 792, 060 |
| Watering..... | do..... | 1, 724, 780 |
| Number plants set out..... | | 464 |
| Number plants grafted..... | | 71 |
| Number plants trimmed..... | | 657 |
| Number trees transplanted..... | | 105 |
| Number trees trimmed..... | | 170 |
| Number benches set..... | | 28 |
| Number cleanings of fountains..... | | 252 |
| Number potted plants watered..... | | 10, 330 |

DEPARTMENT STABLE No. 2.

This stable is under the charge of Mr. T. F. Maher, superintendent of collection of refuse. In it are kept the greater part of the animals employed in the department of street cleaning and parks, and also nearly all of those employed in the water and sewer department. It contains shops in which the animals are shod and the harness and vehicles repaired. The buildings provide quarters for a number of the regular employees in the department of collection of refuse, as well as the employees of the stable. During the period covered by this report a number of animals have developed cases of glanders, and it is feared that a portion of the stable is infected with the germ of this disease. An examination is in progress, the result of which is expected to determine what portion of the stable is affected. No extensive repairs have been made since August 1, 1899. The condition of the animals and vehicles cared for has greatly improved, until at present only a very small percentage of them is unserviceable.

The number of animals cared for and the cost of same for the year are shown by the following table:

Maintenance report of animals at stable No. 2, July 1, 1899, to July 1, 1900.

| Month. | Animals per month. | | | | Cost per animal. | | |
|-----------------|--------------------|--------|-------|--------|---------------------|-----------------------|-----------------------|
| | Horses. | Mules. | Oxen. | Total. | Average daily cost. | Average monthly cost. | Total monthly cost. |
| 1899. | | | | | | | |
| July | 17 | 228 | 36 | 281 | \$0.50 | \$15.46 | \$4,346.70 |
| August | 16 | 264 | 36 | 316 | .74 | 22.98 | 7,264.42 |
| September | 17 | 223 | 36 | 276 | .61 | 18.15 | 5,011.56 |
| October | 17 | 204 | 36 | 257 | .70 | 21.74 | 5,587.97 |
| November | 22 | 207 | 36 | 265 | .63 | 18.95 | 5,022.75 |
| December | 22 | 206 | 33 | 261 | .53 | 16.31 | 4,338.59 |
| 1900. | | | | | | | |
| January | 27 | 202 | 33 | 262 | .416 | 13.86 | 3,688.39 |
| February | 26 | 202 | 36 | 264 | .533 | 14.94 | 3,944.59 |
| March | 23 | 202 | 35 | 260 | .488 | 15.15 | 3,940.09 |
| April | 24 | 199 | 35 | 258 | .453 | 13.61 | 3,511.78 |
| May | 20 | 239 | 37 | 296 | .45 | 13.93 | 4,133.31 |
| June | 20 | 230 | 28 | 278 | .40 | 11.76 | 3,267.89 |
| Total | | | | | | | |
| Average | 21 | 217 | 35 | 273 | .54 | 196.84 16.40 | 54,057.87 4,504.82 |

STABLE NO. 3.

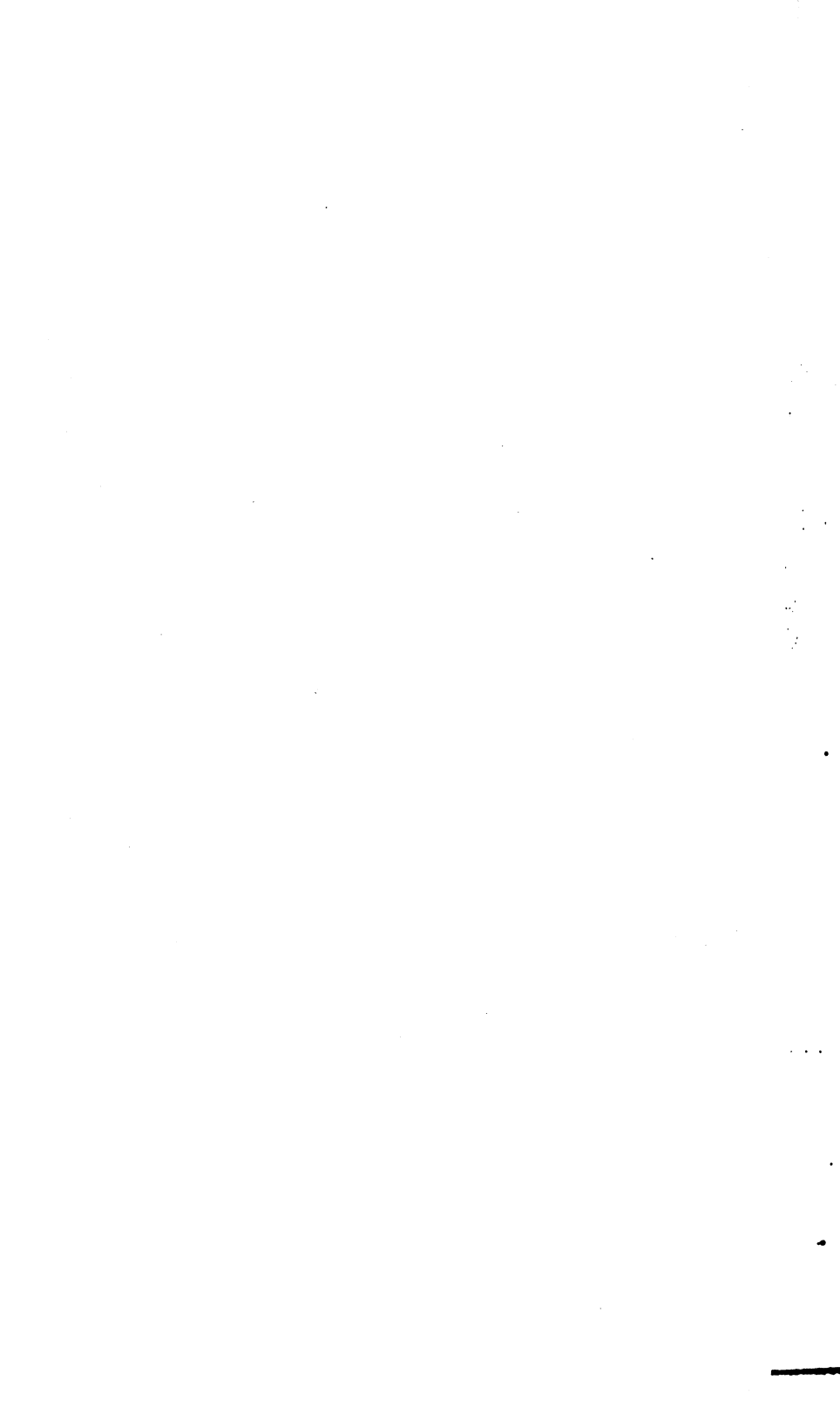
[Mr. William W. Rose, superintendent, in charge.]

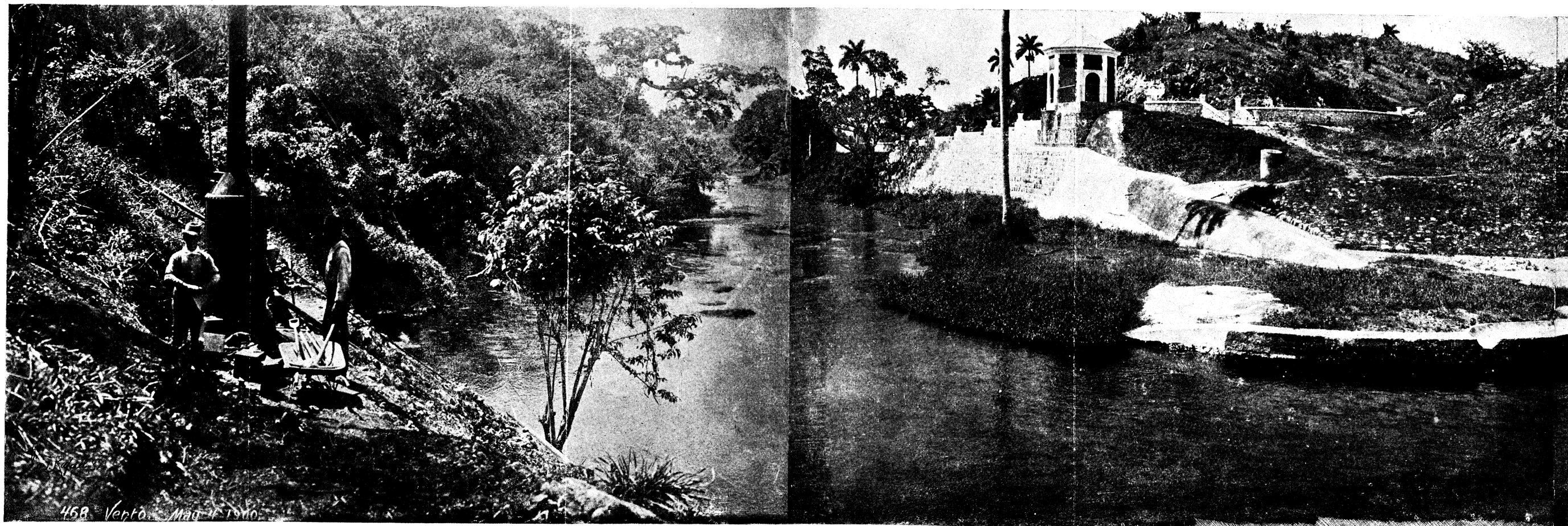
This stable is located on Colon street, between Monserrate and Zulueta streets, and covers an area of 2,022 square meters. All of the animals and vehicles cared for at this stable are used in connection with the street cleaning, street sprinkling, and park departments.

The entire area is paved with granite, concrete, and macadam in such a way that all waste water and urine are carried into the sewer on Monserrate street. The walls are constructed of yellow-pine lumber and the roof is made of No. 24 galvanized iron.

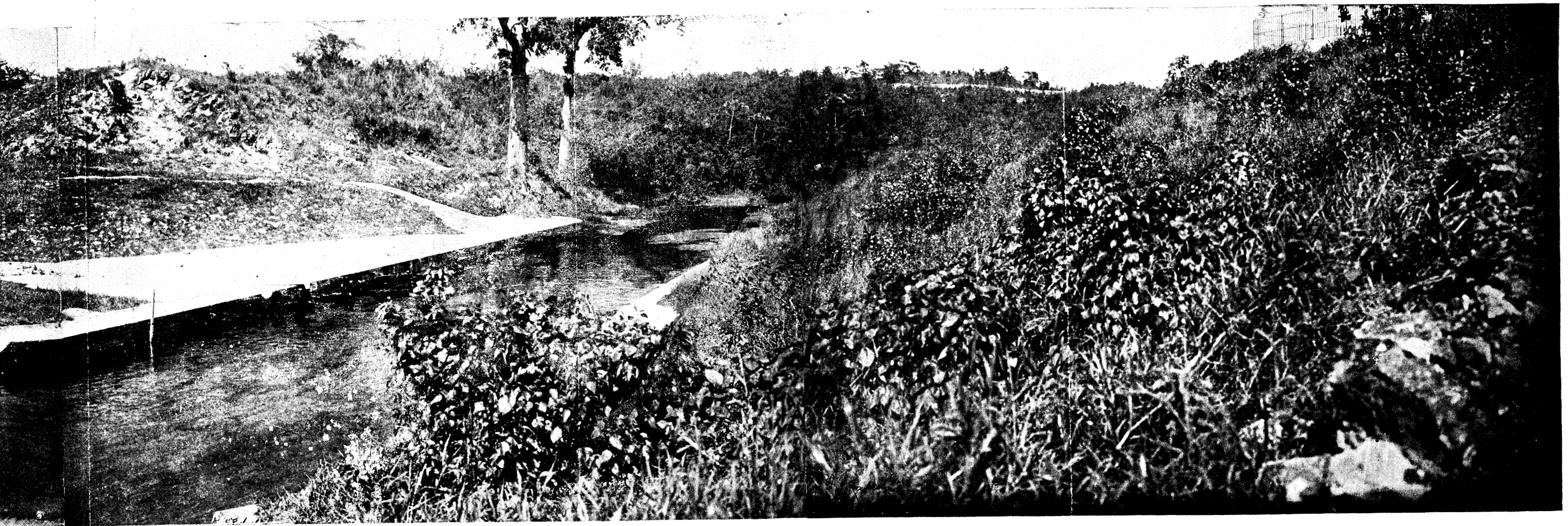
An elevated forage room, in which are bins for the different classes of forage used, is one of the features of this stable. There is an abundant supply of water for the use of the animals, washing vehicles, use in closets and bathrooms, and for the purpose of extinguishing fires, for which all necessary apparatus is provided. The construction of this stable cost \$3,742. All stalls are provided with concrete floors, upon which gratings made of 2 by 6 inch yellow pine are placed, so that the animals always have dry footing. These gratings are removed from the stalls, thoroughly cleansed, and sun dried twice a week. The mangers are of yellow-pine lumber. The entries are paved with concrete.

The relatively high rate of cost of maintenance per animal in this stable is due to the fact that the animals and vehicles are leaving for and arriving from their work at all hours of the day and night, which requires the employment of three sets of men.

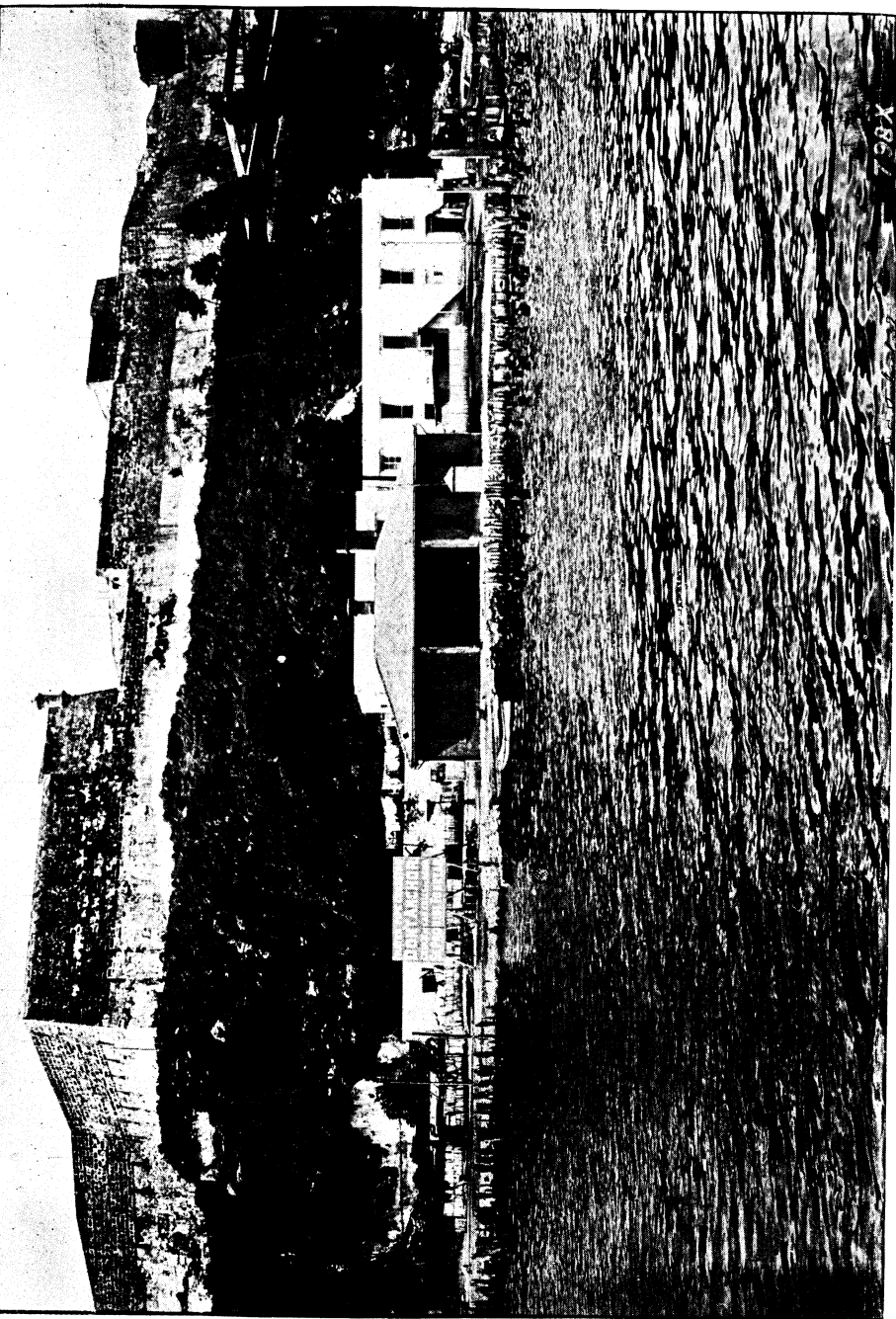




VIEW OF VENTO SPRINGS, SOURCE OF T



SS, SOURCE OF THE WATER SUPPLY OF HABANA.



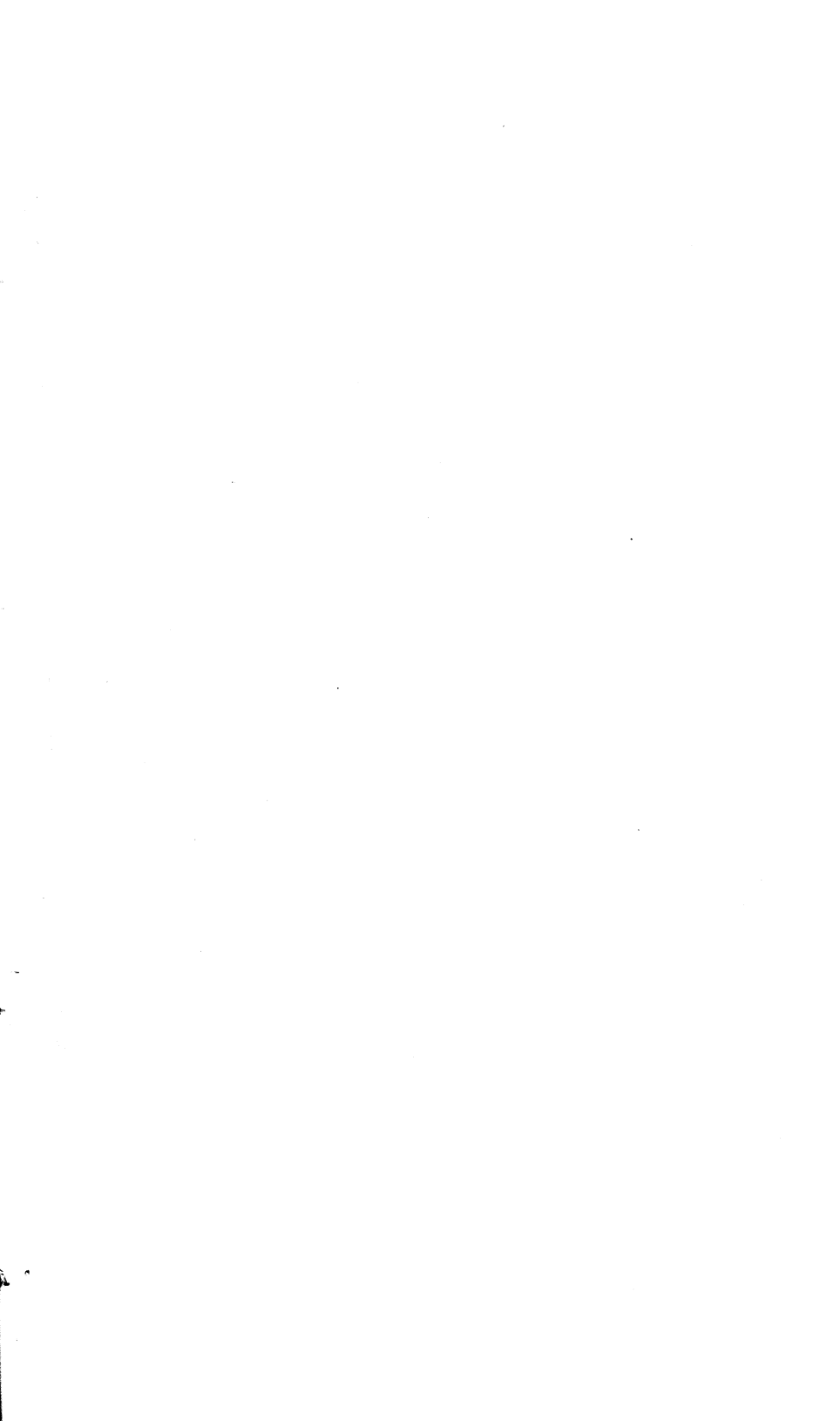
NEW PUMPING STATION AT CASA BLANCA; CABANA FORTRESS IN THE BACKGROUND.



739 X

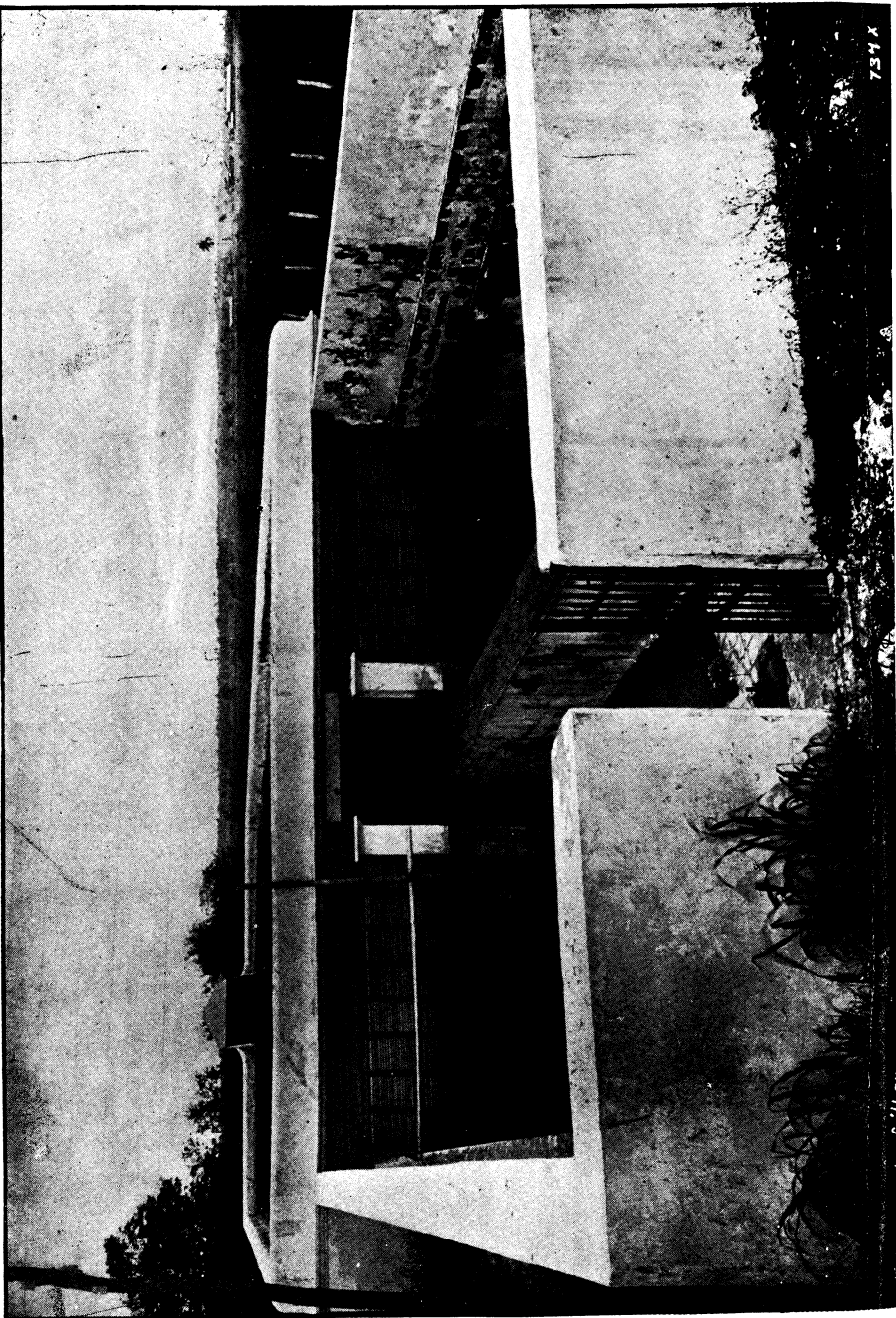
DAM ACROSS ALMENDARES RIVER TO SUPPLY THE

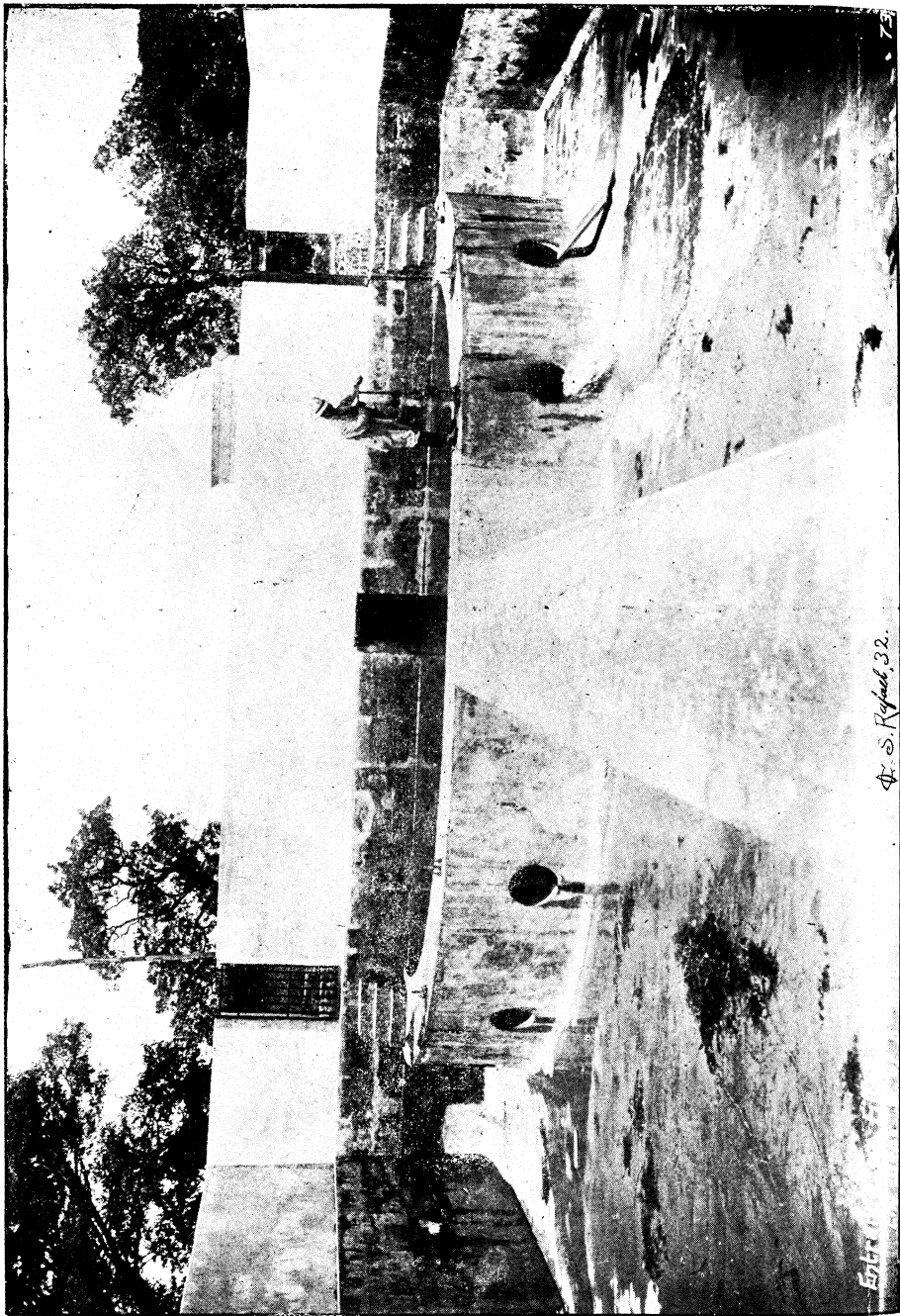
DAM ACROSS ALMENDARES RIVER TO SUPPLY THE ZANJA REAL





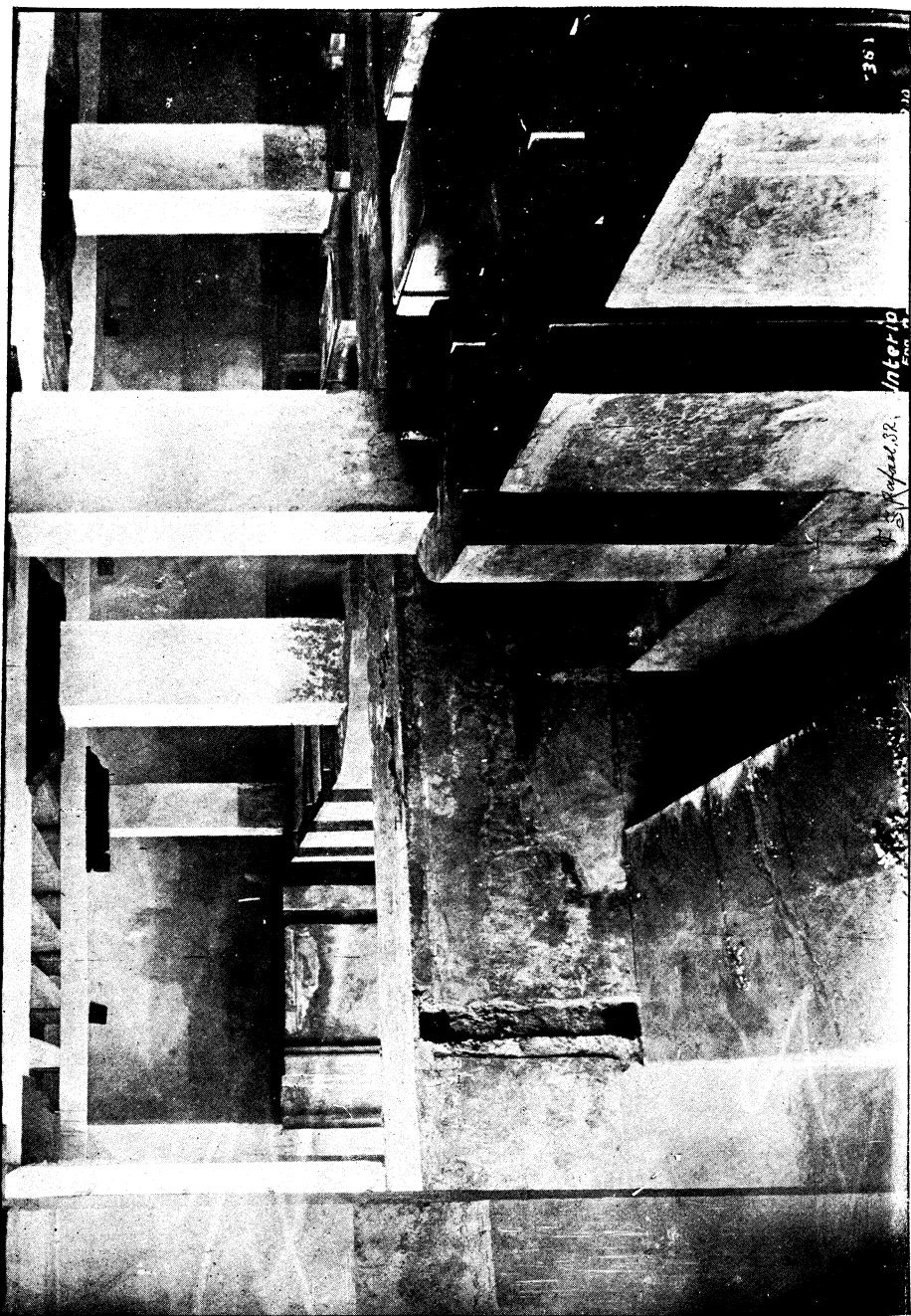
FILTER HOUSE.



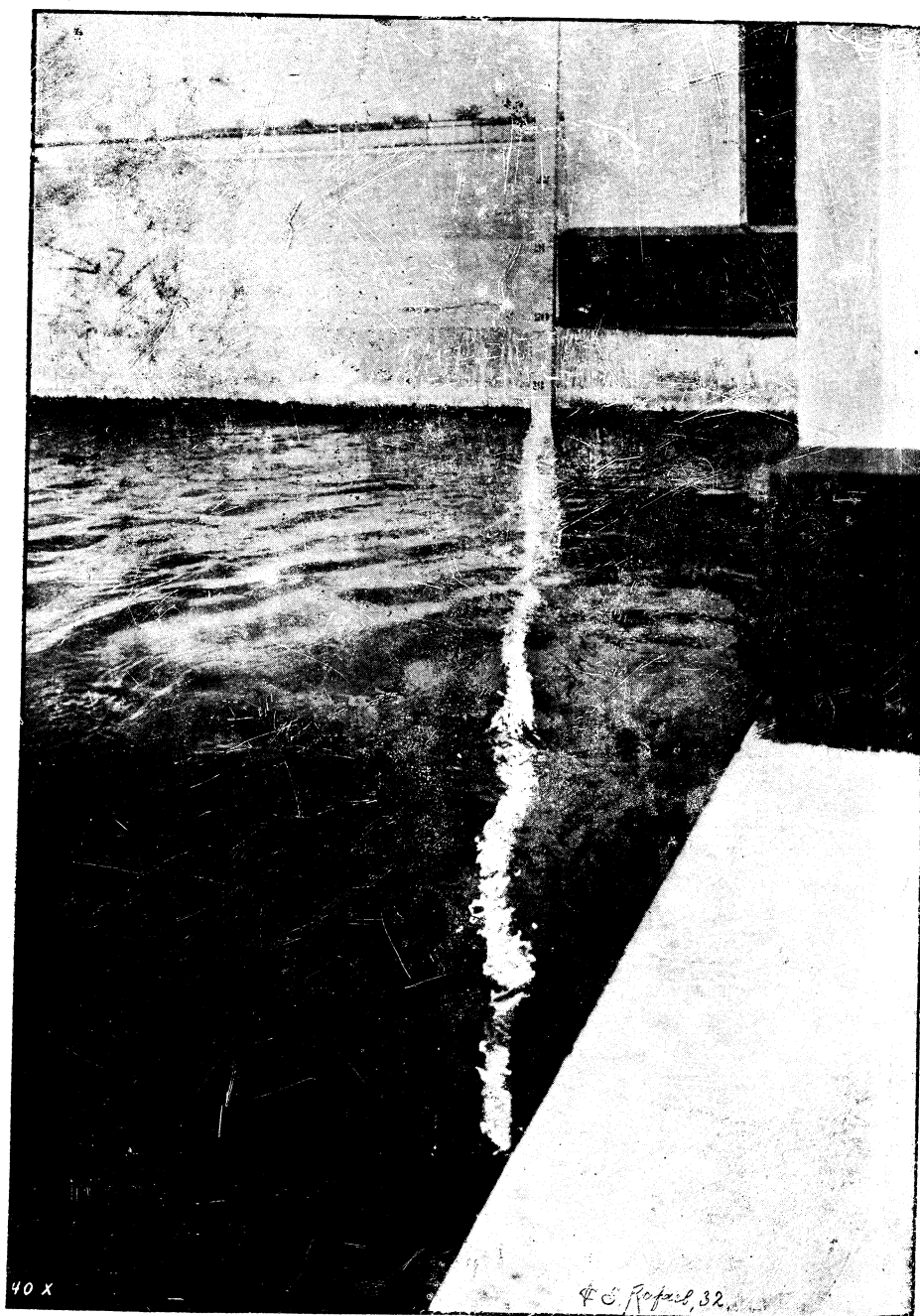


Dr. S. Rajend. 32.

ENTRANCE TO FILTER, SHOWING SUPPLY CANAL AND VALVES



INTERIOR OF FILTER.



40 X

F. S. Roedel, 32

PALATINO WEST RESERVOIR; ROD ON BOTTOM SHOWING CLEARNESS OF WATER.

Maintenance report of animals at stable No. 3, September 1, 1899, to July 1, 1900.

| Month. | Animals per month. | | | Cost per animal. | | |
|-----------------|--------------------|--------|--------|---------------------|-----------------------|---------------------|
| | Horses. | Mules. | Total. | Average daily cost. | Average monthly cost. | Total monthly cost. |
| 1899. | | | | | | |
| September | 8 | 86 | 94 | \$0.75 | \$22.50 | \$2,115.00 |
| October | 9 | 88 | 97 | .77 | 23.87 | 2,315.39 |
| November | 9 | 96 | 105 | .66 | 19.80 | 2,079.00 |
| December | 11 | 93 | 104 | .60 | 18.60 | 1,934.40 |
| 1900. | | | | | | |
| January | 9 | 95 | 104 | .63 | 19.53 | 2,031.12 |
| February | 8 | 95 | 103 | .61 | 17.08 | 1,759.39 |
| March | 8 | 115 | 123 | .65 | 20.15 | 2,478.45 |
| April | 9 | 113 | 122 | .60 | 18.00 | 2,196.00 |
| May | 34 | 105 | 139 | .623 | 19.32 | 2,686.03 |
| June | 38 | 105 | 143 | .64 | 19.27 | 2,755.17 |
| Total | | | | | 198.12 | 22,349.80 |
| Average | 14 | 99 | 113 | .65 | 19.81 | 2,234.98 |

SURVEYS.

[Mr. J. W. Pierce, assistant engineer, in charge.]

The organization of this subdepartment has been of great service, especially in connection with the improvements in the public parks. It was organized on January 1, 1900, but has undergone numerous changes in personnel from resignations and removals. The organization up to May 1, 1900, was as follows: One assistant engineer, in charge; 5 transitmen, 2 rodmen, 1 chainman, and 1 inspector of construction and repair. Owing to the volume and variety in character of work with which this department has been charged, a thorough organization has not yet been effected. It is proposed to specialize the work of each man as soon as possible.

Surveys have been made of many of the existing parks, and new layouts designed for some nearing completion. Most of the work, however, is in an incomplete state. An outline contour map has been made of the town of Regla, and a topographic survey has been started in Casa Blanca.

A survey and plan for a road along the water front of Casa Blanca, to facilitate the collection and disposal of refuse, has been made, and an estimate of quantities for construction almost finished. The street areas in the city districts have been remeasured and the remeasurements of the suburban districts are in progress. The dumping grounds at La Punta and Reina batteries are being graded and plans for their improvement as public places of resort are in preparation.

The unusual amount of surveying which was laid out for the department of street cleaning and parks about the beginning of May made it necessary to increase the force during the months of May and June to some considerable extent in order to complete the work before the end of the fiscal year, at which time it will be reduced to two small parties, which is about the proper complement for keeping up the work of surveying in this department.

As now organized, this subdepartment consists of 3 assistant engineers, 2 of whom were temporarily loaned by the street department, 2 transitmen, 11 rodmen, 2 chainmen, 1 inspector of construction and repairs, and 2 draftsmen.

There are on file 187 plans, varying in character and extent from a design for remodeling a dump cart to a survey of the city of Regla, upon which it is proposed to base estimates for street improvements and drainage.

A survey was made and the notes plotted with a view of establishing a surface drainage system in Battery No. 5.

A monthly average of 2,723 loads of earth, stone, and loam has been received at the two principal dumps (Reina Battery and Punta), and has been thoroughly disinfected and made use of as filling.

SPECIAL SERVICE.

[Mr. Camilo Echarte, superintendent in charge.]

This subdepartment comprises the watchmen and guard service, and all the work of translation required by the department of street cleaning and parks. Under the present management the park guard and watchman service has been brought up to a very high standard of efficiency. It is recognized as an organization by the city police department, and has rendered assistance to it in many instances. The entire force is uniformed. The service is divided into three watches of eight hours each, with no intermission.

The average number of men employed is about 70, the department organization being as follows: 1 superintendent, 1 clerk, 3 inspectors, 3 subinspectors, 3 foremen, 40 park guards, and 27 watchmen at the different stables, dumping grounds, etc.

Communication between the various parks and the central office is had over the city fire alarm and police telephone circuits, call boxes for which are located in convenient places for official use.

During the months of May and June the service has been greatly improved. It is giving aid constantly to the police and to the public. The force is not only uniformed, but is now in possession of water-proofs and rubbers, so that the service suffers no interruption from inclement weather.

The telephone communication has also been improved by the installation of two more telephones, one at Trillo Park and one at Cortina de Valdes. This last place is very important owing to its situation near the main office. Three guards are quartered in the house at the south end and attend to the telephone, which has been put in communication with all others of the department.

The wages of the watchmen range from \$1 to \$1.50 per day; guards, from \$1.25 to \$1.50 per day; foremen, \$50 per month; subinspectors, \$60 per month; inspectors, from \$75 to \$90 per month; clerk, \$75 per month, and the superintendent \$100 per month.

DEPARTMENT OF WATER AND SEWERS.

[Mr. A. W. Cooke, assistant engineer, in charge.]

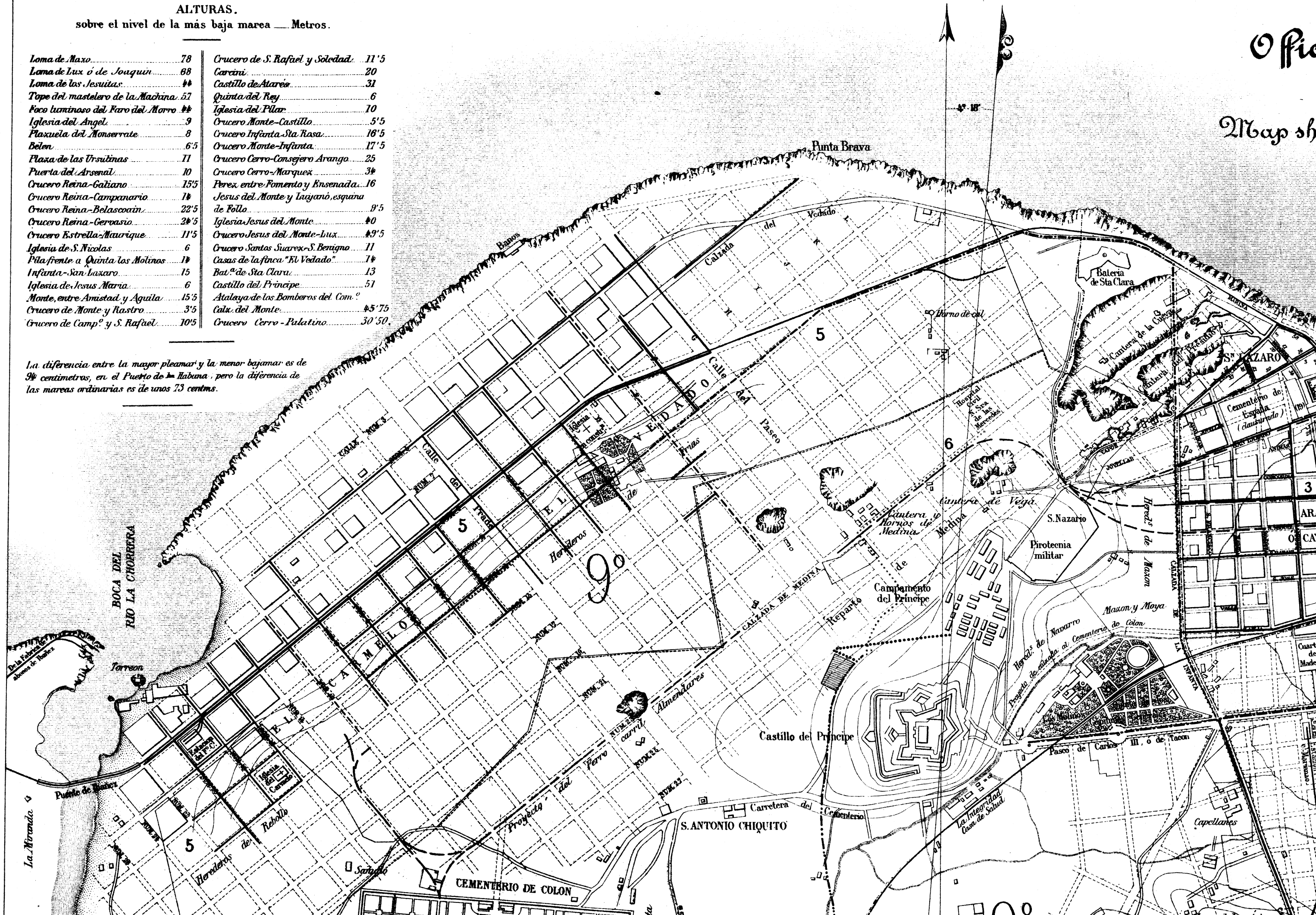
This department comprises the following branches:

Water department: Mr. A. Jadin, superintendent of installation of main and service pipes; Mr. A. Van Driessche, superintendent of aqueducts and reservoirs; Mr. D. Torrens, in charge of inspection of water waste and meters; Mr. Eduardo Adot, permit clerk. Sewer department: Mr. E. A. Giberga, in charge plumbing, house drains, and electrozone plant, until June 1, 1900; Mr. R. H. Keays, in charge

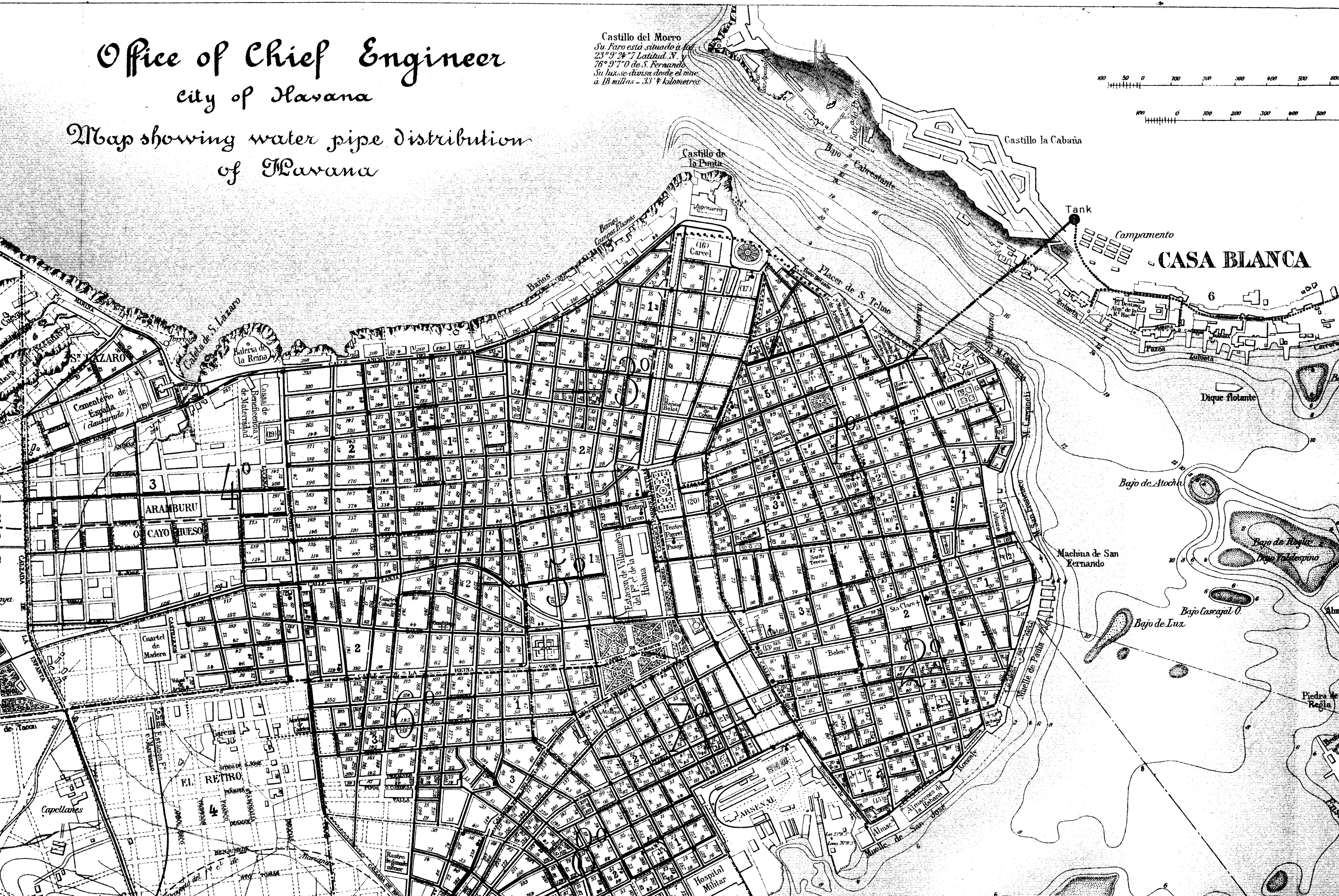
ALTURAS.
sobre el nivel de la más baja marea — Metros.

| | | | |
|---------------------------------------|------|----------------------------------------------------|-------|
| Loma de Maxo..... | 78 | Crucero de S. Rafael y Soledad..... | 11'5 |
| Loma de Lux ó de Joaquín..... | 68 | Carcén..... | 20 |
| Loma de los Jesuitas..... | 44 | Castillo de Atarés..... | 31 |
| Tope del mastelero de la Máquina..... | 57 | Quinta del Rey..... | 6 |
| Foco luminoso del Faro del Morro..... | 44 | Iglesia del Pilar..... | 10 |
| Iglesia del Angel..... | 9 | Crucero Monte-Castillo..... | 5'5 |
| Plazuela del Monserrate..... | 8 | Crucero Infanta-Sa Rosa..... | 16'5 |
| Belen..... | 6'5 | Crucero Monte-Infanta..... | 17'5 |
| Plaza de las Ursulinas..... | 11 | Crucero Cerro-Consejero Arango..... | 25 |
| Puerta del Arsenal..... | 10 | Crucero Cerro-Marquez..... | 34 |
| Crucero Reina-Galiano..... | 15'5 | Perez entre Fomento y Ensenada..... | 16 |
| Crucero Reina-Campanario..... | 14 | Jesus del Monte y Lujano, esquina de Follo..... | 9'5 |
| Crucero Reina-Belascoain..... | 22'5 | Iglesia Jesus del Monte..... | 40 |
| Crucero Reina-Gervasio..... | 24'5 | Crucero Jesus del Monte-Lux..... | 49'5 |
| Crucero Estrella-Maurique..... | 11'5 | Crucero Santos Suarez-S. Benigno..... | 11 |
| Iglesia de S. Nicolas..... | 6 | Casas de la finca "El Vedado"..... | 74 |
| Pila frente a Quinta los Molinos..... | 14 | Bat.ª de Sta Clara..... | 13 |
| Infanta-San Lázaro..... | 15 | Castillo del Principe..... | 51 |
| Iglesia de Jesus Maria..... | 6 | Atalaya de los Bomberos del Com.º..... | |
| Monte, entre Amistad y Aguila..... | 15'5 | Calx. del Monte..... | 45'75 |
| Crucero de Monte y Rastro..... | 3'5 | Crucero Cerro-Palatino..... | 30'50 |
| Crucero de Camp.º y S. Rafael..... | 10'5 | | |

La diferencia entre la mayor pleamar y la menor bajamar es de 94 centímetros, en el Puerto de la Habana, pero la diferencia de las mareas ordinarias es de unos 75 centms.



Map showing water pipe distribution
of Havana



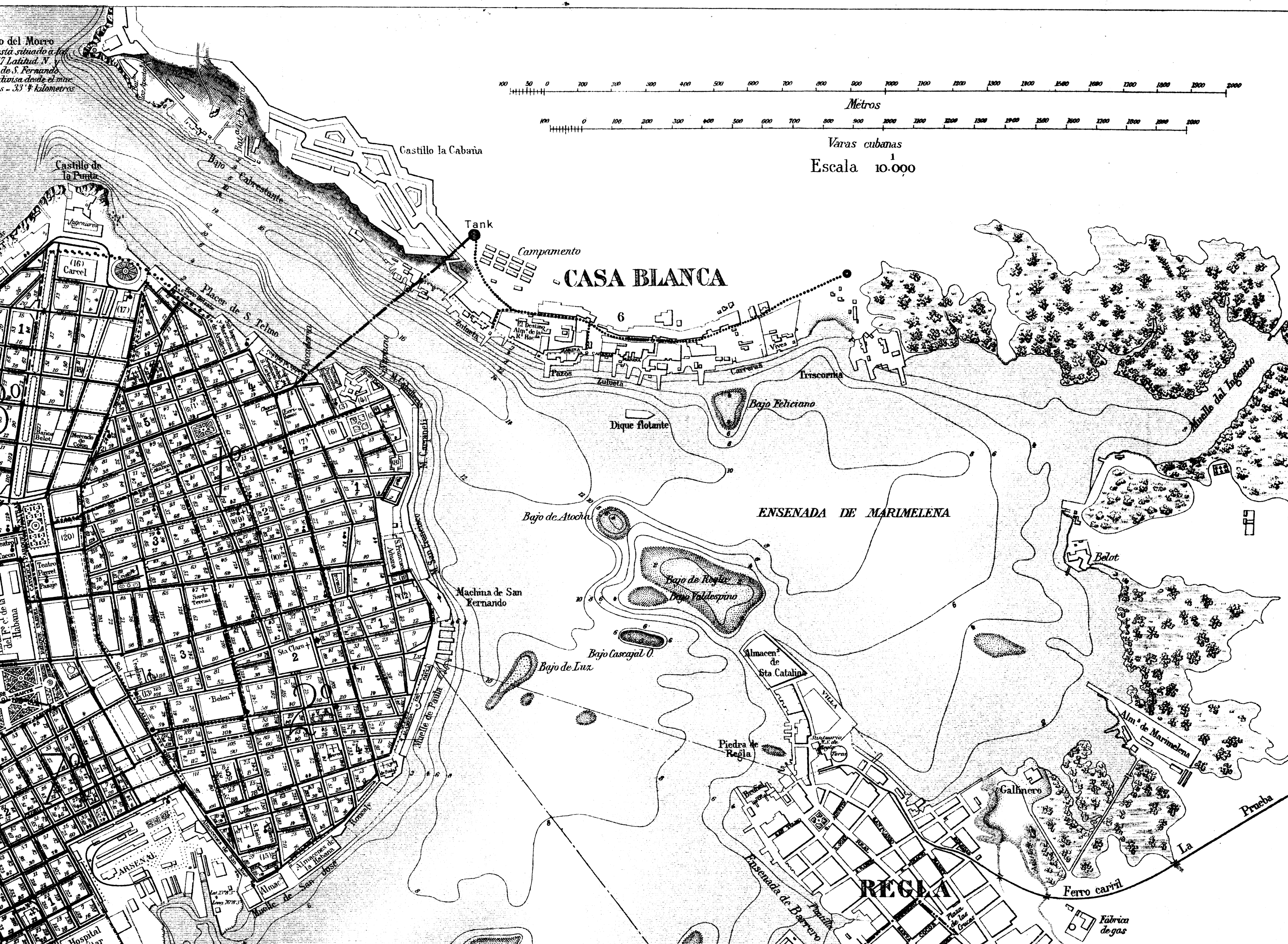
o del Morro
sta situado a lat
7 Latitud N y
de S. Fernando
divisa desde el mar
s = 33' 4 kilometros

100 50 0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000

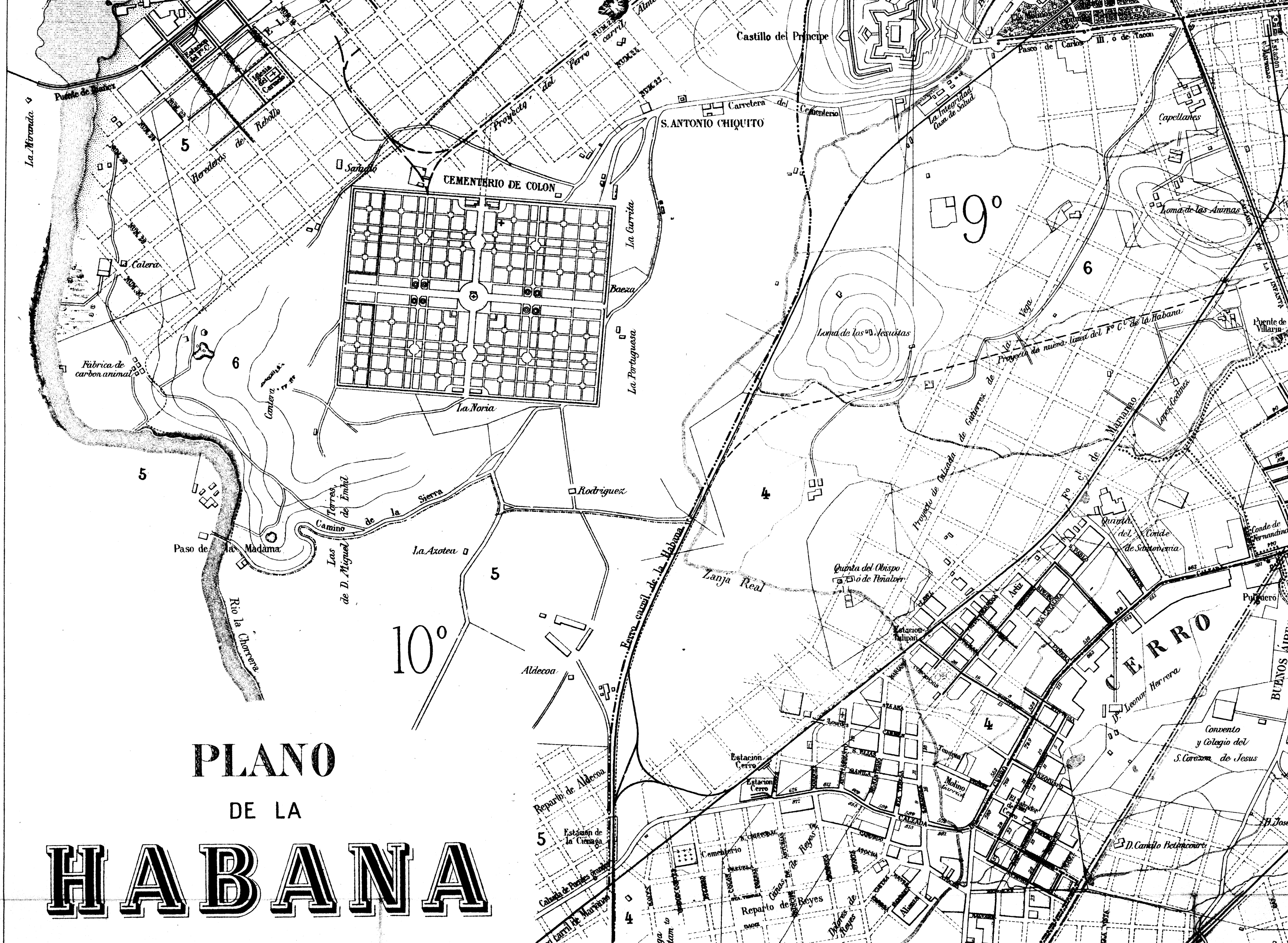
Metros

100 0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000

Varas cubanas
Escala 10.000



PLANO
DE LA
HABANA







DIRECTORIO

(1) Parada del Ferro carril Urbano.

Academia de ciencias medicas.

PLANO DE LA HABANA

POR
D. ESTEBAN T. PICHARDO,
AGRIMENSOR Y MAESTRO DE OBRAS.

EDITOR: D. JOSÉ VALDEPARES.

Para la formación de este Plano, se han tenido presentes: el publicado por el Excmo. Ayuntamiento, el del Puerto por los Ingenieros de Obras públicas y otros debidos a los Sres. D. Mariano Carles, D. José Ocampo, D. J. Manuel Alvaro, D. Alberto de Castro, D. Antonio Ariza, D. José Lopez Trigo, D. José C. del Castillo, D. Simon Teja &c; cuyos trabajos ha combinado el Autor del presente, añadiendo los que practicó expreso sobre el terreno.

Las curvas de igual sonida, dibujadas en el Puerto, indican la profundidad del agua de dos en dos metros, en baja mar, y están deducidas del sondeo verificado por O. públicas en 1874.

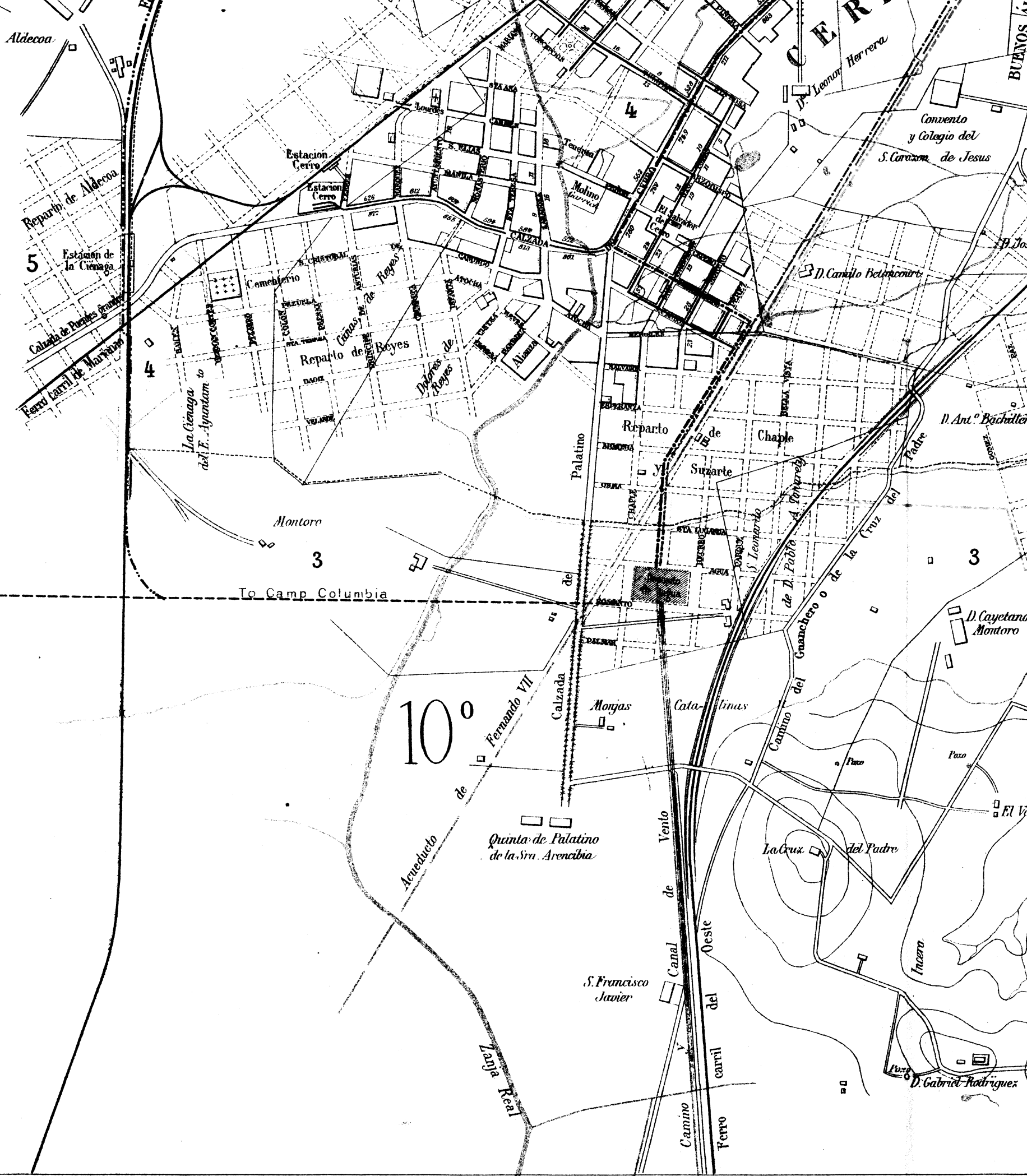
- 5 Estac. telegráfica
- Caja de agua
- ◆ Caja y sifón
- Sifón
- Ferro carril en explotación
- - - Idem en proyecto
- † Parroquia
- - - - - Límite Municipal
- - - - - Idem de Distrito municipal
- - - - - Idem de Barrio
- +++++ Idem de Parroquia

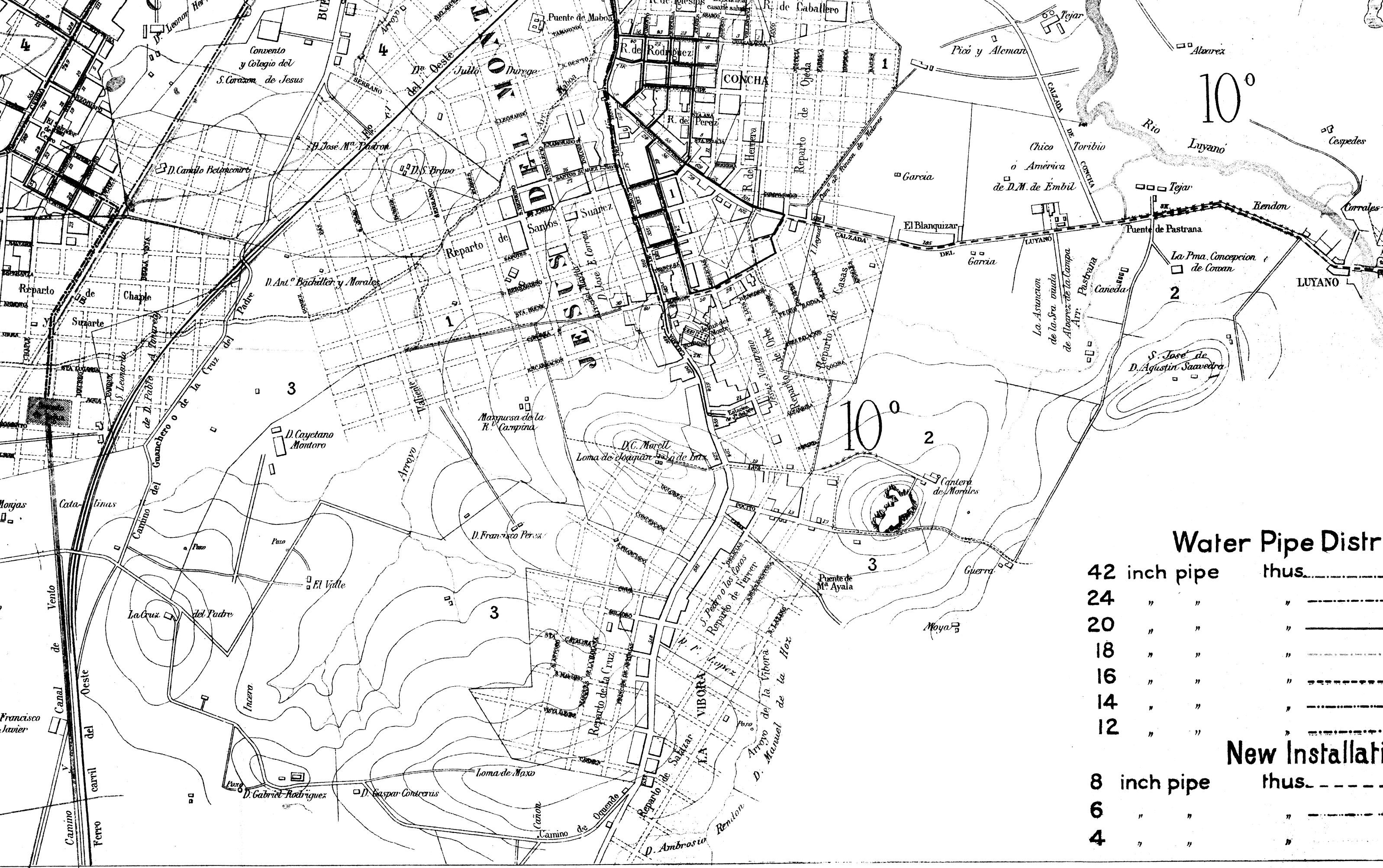
Los números de las casas corresponden al último de cada frente de manzana y están escritos en carácter itálico, como 1,2,3.

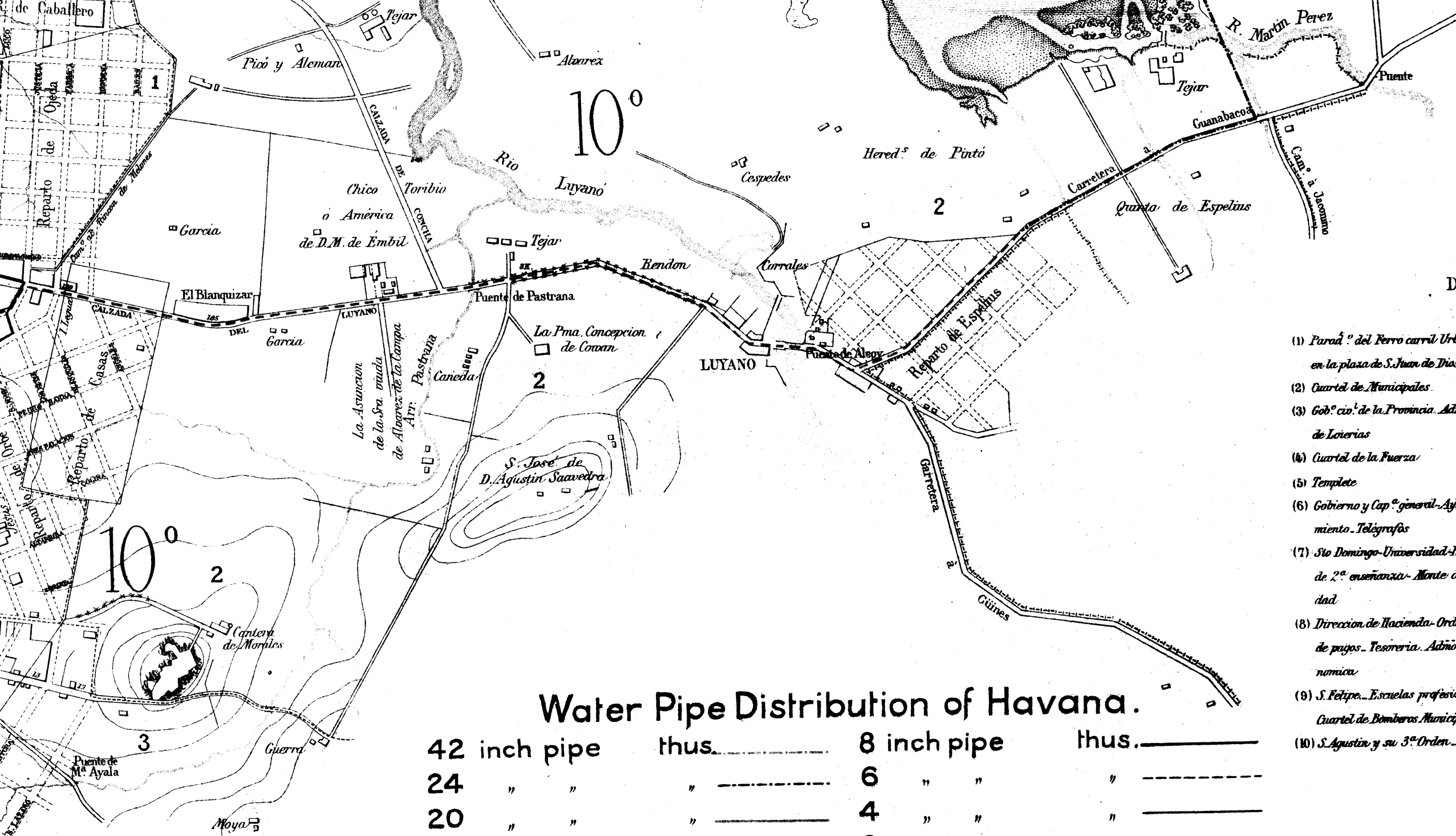
Los que se refieren a la numeración del Directorio, están escritos en carácter romano, y entre paréntesis: (1)(2)(3)(4).

Los ordinales de los Distritos municipales son de carácter capitales y llamano grande: 1º

Los de los barrios son de carácter romano, mayores que los del Directorio: 1,2,3







Water Pipe Distribution of Havana.

| | | | |
|--------------|-------------|-------------|-------------|
| 42 inch pipe | thus. _____ | 8 inch pipe | thus. _____ |
| 24 " " | " _____ | 6 " " | " _____ |
| 20 " " | " _____ | 4 " " | " _____ |
| 18 " " | " _____ | 3 " " | " _____ |
| 16 " " | " _____ | 2 1/2 " " | " _____ |
| 14 " " | " _____ | 2 " " | " _____ |
| 12 " " | " _____ | | |

New Installation since last report.

| | | | |
|-------------|-------------|-------------|------------|
| 8 inch pipe | thus. _____ | 3 inch pipe | thus. |
| 6 " " | " _____ | 2 1/2 " " | " |
| 4 " " | " _____ | | |

DIRECTORIO

- | | |
|--------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| (1) Parada ^o del Ferrocarril Urbano, en la plaza de S. Juan de Dios | Academia de ciencias medicas, fisicas y naturales. |
| (2) Cuartel de Municipales | (11) Admon. de Correos - Intervencion de Marina - Deposito hidrografico |
| (3) Gob. ^o civ. de la Provincia. Adm. ^o de Lenerias | (12) Comand. ^o gral. del Apostadero |
| (4) Cuartel de la Fuerza | (13) Cuartelillo Bomb. ^o municipales |
| (5) Templo | (14) Cuartel Bomb. ^o del Comercio |
| (6) Gobierno y Cap. ^o general - Ayuntamiento. Telegrafos | (15) Casa de Recogidas, de S. Juan Teponaceno |
| (7) Sta. Domingo - Universidad - Instituto de 2. ^a enseñanza - Monte de piedad | (16) Carcel. Presidio Hospital civil de S. Felipe y Santiago |
| (8) Direccion de Hacienda - Orden ^o de pagos - Tesoreria. Adm. ^o Economica | (17) Morgue o Necrascomio Obras municipales |
| (9) S. Felipe - Escuelas profesionales - Cuartel de Bomberos Municipales | (18) Asilo de S. Jose, de Artes y Oficios |
| (10) S. Agustin y su 3. ^a Orden | (20) Teatro de Alhuxu, o de Lerundi Casino español |
| | (21) Cuartel de la Guardia civil |

Office of Chief Engineer
Division of Cuba.

To accompany Report of June 30th, 1900.

W. H. Bush

Major Corps of Engineers U.S.A.
Chief Engineer Division of Cuba.

of surveys for new sewer system, with Mr. J. E. Hoffman as assistant; Mr. Michael O'Neill, in charge of sewer cleaning and repairs; Mr. William Kennedy, in charge of night soil department; Mr. B. F. Davenport, in charge of city plats of water and sewer connections.

WATER DEPARTMENT.

The improvement of the water supply of the city has embraced the following works: 1, Installation of new house service pipes; 2, replacing old house service pipes; 3, installing new fire hydrants; 4, repairing old fire hydrants; 5, dividing the water-main system throughout the city into subdistricts controlled individually by the operation of gate valves; 6, extension of new mains to (occupied) territories without water, in the city proper; 7, reducing friction in existing mains by cross connections and increasing the radii of curves; 8, increasing the pressure heads on the higher levels by controlling the flow of the lower levels; 9, furnishing a water supply to the suburbs; 10, increasing the volume of water flowing through the masonry aqueduct from the Vento Springs to the city reservoirs.

During the past year there were laid, by request of owners, and upon payment of the usual fee, namely, \$15, 930 new service pipes to houses previously without a direct water supply. Connection was made from the top of the main where depth of the pipe was sufficiently below the surface of the street to be safe from possible fracture by street traffic; otherwise, from the side of the pipe. A brass standard "Corporation" cock is placed at one end of the nipple, screwed into the main; the service is then extended to a point 18 inches inside of the curb or sidewalk line where a brass service cock is placed on the end of the pipe ready for the house connection. Owing to difficulty in obtaining the services of mechanics competent to make lead-joint connections, it was not deemed expedient to use lead pipe for this work. The class of pipe used was extra heavy galvanized iron, lead lined, which has proven satisfactory and seems to withstand the attack of the salts found in the formation underlying the surface throughout the city.

While under the control of the Spanish authorities, cast and wrought iron material, principally the latter, was used in the performance of this work. The quality of this latter material is such that, after being under ground four or five years, the pipe is found to have practically disintegrated, causing innumerable leaks which compel immediate renewal of services thus made useless. As a result of this former method of construction, services were found leaking and in bad condition, making it necessary to replace them with new services. Whenever a leak of this kind is found, the pavement is removed to permit an excavation sufficient to expose the full length of the pipe, and in nearly all cases such services require to be replaced with new material throughout.

There are 400 fire hydrants installed at different points throughout the city. Nearly all are of the flush pattern. This style was adopted on account of the narrow streets and sidewalks. They are fitted with a valve and two arms with 2½-inch hose nozzles. The valves and valve-seats are in need of constant repair, which is done at night, owing to the absence of auxiliary valves, which makes it necessary to shut off the supply of water to large areas of the city in which the hydrant is located. To obviate this objection, 4-inch gate valves are

now being placed on the lateral pipes from the mains to the hydrants. All new hydrants are furnished with a controlling valve, thus removing the necessity of shutting off a portion of the city from a supply of water, and permitting the repairs to be made during the day.

No record of the location or number of valves controlling the main water pipes of the city was found in the files of the former city government. One or two old employees (by reason of their connection with the department in 1893, when the principal mains were laid) claimed to be able to assist in the procuring of much-needed data. Depending entirely upon their memories, this source of information was not considered reliable, as was proven later when more practical methods of investigation were employed. However, during the past year all the old valves have been located and repaired. Many of the valves of the Fernando VII system were found to have been almost entirely destroyed, apparently in former attempts to operate them. The stems were broken and the disks partly closed. In some instances, it was found that when installed no yarn had been packed into the joints, thus permitting the lead filling to flow through the joint, creating an impediment and obstruction to the flow of water. The valves have all been placed in chambers and properly recorded and plotted in book form, so that their location can always be readily ascertained. The mains of the system of 1893 were found to be in good condition.

Owing to the limited number of valves on the main system, a large territory was deprived of water whenever repairs to breaks were made, or modifications required in the line. These objectionable features have been partly overcome by dividing the city into small independent water circuits. With the installation of many new valves the danger of shutting off the water from large and populous districts is avoided.

Inspection of the accompanying chart is respectfully invited, wherein are shown the different circuits as now established. The work of extending the valve system is still progressing.

The extension of new mains to districts of the old city previously without water, has progressed in accordance with funds appropriated for this purpose; and in some cases small and inadequate pipes have been replaced with pipes of larger dimensions.

Cross connections of the existing system have been made at many intersections, improving considerably the pressure of the locality.

Since the American occupation a water supply has been furnished to Casa Blanca and the town of Regla—both suburbs of Habana, though Regla is a separate corporation. The water supply to Casa Blanca (which also embraces the supply to the garrisons at Morro and Cabana) is carried, through a 6-inch flexible-joint cast-iron pipe, from a connection with the city main at the foot of Empedrado street, across the main channel to Habana Harbor, to the opposite shore immediately under Cabana Fortress. The greatest depth of water in the channel along the line is 56 feet. The pipe was lowered to the bottom on an inclined timber skid or runway, which was hinged to an inclined platform constructed on the side of a barge. The skid was made in three pieces—two 60 feet long each and one 30 feet long, in all 150 feet—which was found to be of sufficient length to reach the greatest depth at an angle with the bottom not injurious to the flexible joints. The skid was suspended by one-half-inch galvanized iron chains attached to

hangers made of $\frac{1}{2}$ by $2\frac{1}{2}$ inch iron. The chains supporting the portion of the skid farthest from the barge were brought on board a lighter, being led over iron sheaves fastened in timbers that were lashed on the crossways of the boat and projecting over the sides sufficiently to afford clearance in raising or lowering the skid. On each timber was rigged tackle for raising or lowering the skid. A scale of depths for each chain was calculated, and the chains lowered accordingly as the work reached deeper water, and raised again on reaching more shoal water.

During the progress of the work the scows were anchored to pairs of car wheels placed at convenient distances on each side, to which the four corners of the scow were securely fastened. The pipe was jointed on the inclined platform connected to the skid. The pipe was placed on rollers and allowed to gradually slide down the skid into place on the bottom, in measure as the scows were moved forward.

The general plan and method above described were designed by Mr. Howard Egleston, who was awarded the contract to perform the work. To prevent any longitudinal strain coming on the joints, due to sliding friction of the ways, the contractor was required to run through each piece of pipe, when jointed, a three-fourths inch cable for the purpose of relieving the strain from the joints during the movement of the scow. One end of the cable was fastened to the shore; the other, after the cable was drawn taut, to a crosspiece across the end of the last pipe placed on the skid.

Thirteen hundred and sixty-seven feet of pipe were satisfactorily laid in this manner.

The joints used had a flexibility of 10 degrees. The joint admits of the lead gasket moving on the interior service of the bell, which is carefully machined.

The water from the pipe just described discharges, under a varying gravity head of from 12 to 18 feet, into a wet well, from which an 8-inch suction pipe is connected to a cross compound condensing engine that pumps into a steel tank 30 feet in diameter and 40 feet deep, erected on the high ground 137 feet above the pump discharge pipe. From this tank the water is distributed to the garrisons and the town of Casa Blanca, through cast-iron distributing mains.

Before the completion of this system, the inhabitants were dependent upon a few local wells, more or less contaminated, or water supplied from Habana mains, carried across the harbor in boats and delivered in a central tank, from which it was sold by a contractor at the rate of 2 cents per gallon; the people carrying the water from this central point of distribution to their respective homes.

This improvement has added much to the health of the community, affording an adequate supply of wholesome water to all the citizens of the town.

A water main has recently been laid a distance of 21,000 linear feet, from a connection with the 20-inch main on the corner of Jesus del Monte and Mangos street to the market square of the town of Regla. Regla is situated on the bay opposite Habana, and has a population of about 9,000. It is the terminus of a branch railroad operated by the United Railways of Habana; besides, it has a dry dock, several large iron foundries, and a plant for the operation of an electric railway. Heretofore the only means of water supply was from local cisterns for the storage of rain water, and water was supplied from the Havana

mains, delivered into boats which carried it across the harbor to be transferred to distributing wagons and sold at the rate of 2 cents per gallon.

The said pipe line follows the Luyano road through the village of the same name. The inhabitants of Luyano are allowed to tap the main for a domestic supply.

From 300 to 1,000 head of cattle are daily corralled at this point, awaiting shipment to the city slaughterhouse. Heretofore the water supplied to the cattle was taken from the bed of a stream, nearly stagnant the greater part of the year, and unfit for such purposes. A 2-inch connection was made with the main passing the corral, from which an ample supply of water is now furnished to the said corral. After leaving the Luyano road, the pipe line follows the Guanabacoa road a distance of 4,583.6 feet, thence follows the marsh land around the head of the bay to the limits of Regla. From this point the line extends through the town to the market place, thus affording an important center of population a supply of wholesome water, which the inhabitants had petitioned for in vain during the administration of the Spanish Government.

Although the system is not as elaborate or extensive as might be desired, nevertheless it is sufficient to meet the pressing need for domestic use. As an appreciation of the completion of this improvement the citizens made a gala day of the 15th of April, 1900, everybody who could possibly do so turning out on the streets in procession to celebrate the occasion.

Several of the connections with the great mains direct from the reservoirs have been improved by removing the bad form of elbows originally laid, and replacing them with others of larger radius, thereby reducing the friction head to a minimum.

The main gate valves, placed for the purpose of controlling the water flowing to the lower levels of the city, are operated with a view of preventing the pressure head of the higher levels from falling below the point of utility.

The troops at Camp Columbia, Quemados, Fort Principe, and Military Hospital No. 1, which localities are all above the city gravity supply, have been supplied with Vento water by a pumping station located at Palatino. This plant was erected by the Quartermaster's Department in December, 1898, and was operated by that department until March, 1900, when it was transferred to the engineer department of the city of Habana.

The boilers originally installed were in bad condition and were not adequate for the military service and the supply of Aldecoa and Mercedes hospitals, which had been connected with that system. To meet the needs of these services, the construction of a new pumping station was authorized, and during the fiscal year the foundations for the new buildings were laid, three Worthington water-tube boilers of 100 horsepower each were installed, a brick smoke stack was almost completed and specifications for one 800,000-gallon horizontal compound condensing pumping engine were prepared, as well as plans and specifications for the building. The pumps at the existing pumping station will be transferred to the new plant and will be used for the Camp Columbia-Quemados supply. The new 800,000-gallon pump will supply the highest portion of the Cerro, which so far has had no water supply,

and the present Aldecoa Hospital, Fort Principe, Mercedes Hospital line. This pump will also give water service to those portions of the Vedado heights which are above the gravity supply. This plant is designed with a view of increasing its capacity, as soon as funds are made available, for the supply of the higher portions of Jesus del Monte, which have not so far had any water other than that derived from cisterns and wells. It is expected that the plant will be completed during the month of September.

So far as can be learned, the first attempt to bring water into the city was made at the close of the sixteenth century. A dam was built across the Almendares River, at a point about a mile above Puentes Grandes, to furnish the head of water for the flow through the Zanja Real, the head of which is immediately above the dam.

The Zanja Real is an uncovered aqueduct which reaches the city at a point near the present reservoirs. From this point the ditch is divided into many branches, the water from which ultimately makes its way into the bay, through Agua Dulce, the Matadero and San Lazaro Creeks, and through the city sewers. The water in this aqueduct is now so contaminated that it is unfit for drinking within the built-up portion of the city, but the Zanja Real may be made a valuable source of income for the city, by the sale of water for manufacturing purposes. At present the water is used for irrigation and for power; partly under former grants, and partly without authority. The charges for the water, where charges are made, are absurdly low, and the Zanja now is a source of outlay rather than of income to the city. The numerous small streams taken from it are not properly conducted, and the contamination caused by them, particularly in the Cerro and neighboring regions, is without doubt a source of illness.

The dam is in very bad condition and needs extensive repairs. It is said that no work has been done on it for about two hundred years. It is proposed to make it tight and to raise its crest to its original level at an early date.

The Zanja Real has been cleaned from time to time throughout its entire extent, which is necessary, due to the rapid growth of vegetation and the misuse of the canal for sewerage purposes, but much work is necessary on the entire Zanja Real in order to put it on a business basis.

In 1837 a set of filter beds was constructed close to the Almendares River a short distance above the dam, and from these beds a 20-inch iron main was laid into the city. This was termed the aqueduct of Fernando VII. These filter beds, though of antiquated type, are in comparatively good condition, and can be utilized to bring in the Almendares water, should there be a break in the Canal de Albear (Vento Aqueduct). The Almendares water at this point has been shown by test to be free from contamination, excepting from such suspended material as can be readily removed by filtration.

The source of the present water supply of Habana is located at Vento, from which point the water is carried north by gravity to the reservoirs, a distance of 10,000 meters, through a masonry aqueduct, oval in form, with horizontal and vertical axes of 6.56 feet and 7.93 feet respectively. The water, pure and abundant, flows from the base of a range of limestone hills. Water from this source will prove ample to supply the increased quantity required for many years to come, but the present aqueduct is now being used to its full capacity.

In 1886, during the construction of the Vento Aqueduct and before its entire completion, together with the reservoir system, a branch main of 20 inches diameter was run from the Vento Aqueduct at a point opposite the filter beds, to the filter beds; the Almendares River water was cut off from the beds and from that time until the completion of the Vento system in 1893, Vento water was supplied through the aqueduct of Fernando VII. On the completion of the Vento system, that portion of the aqueduct of Fernando VII to the south of Palatino was cut off and has not since been used. During the past year the filter beds and the connections between them and the Vento Aqueduct as well as the aqueduct of Fernando VII were thoroughly cleaned and repaired. The old gate valves were all repaired or renewed. The 20-inch main was cleaned by opening the manholes and passing through the pipe a metal ball armed with sharp pricks to cut away the incrustations, the ball being forced through under water pressure. By this means an auxiliary source of supply either from Vento or from the Almendares River direct is available in case of accident to the Vento system.

Efforts were made early this year to increase the pressure head throughout many parts of the city where the water service was unsatisfactory, by the proper placing of valves on the mains, increasing the number of cross-connections, and stopping, whenever possible, the reckless waste of water by consumers. With this object in view a corps of reliable and competent inspectors were directed to make a house-to-house inspection to locate the cause of the great waste of water which was evidently the reason of the unsatisfactory water service. As this branch of the public service had been heretofore neglected, many fixtures were found in bad condition, resulting in an enormous waste of water. No attempt was made by householders, in many instances, to close the water spigots, thus allowing the water to flow at all hours.

Water closets were found without tanks, and those with tanks had defective valves, so that nearly all closets were found with a constantly flowing stream, without flushing or cleaning the closet bowl and creating a corresponding reduction of the water pressure in the pipes.

Water would not reach houses located on the higher elevations of the city during the day, nor the second floor at any time.

As a result of the care exercised in placing the valves on the mains, increasing the number of cross-connections, and stopping as far as possible the reckless waste of water by consumers, the pressure throughout the city has been increased by 3.7 meters. While this figure represents the average, at many points the pressure has been actually increased 6 meters; and in the lower parts of the city, where the pressure head was excessive, a decrease has been effected.

A computation of the quantity of water daily consumed indicated a consumption of 170 gallons per capita of the population, which proved that more than twice as much water was being wasted as was consumed for legitimate use.

Owing to the great and careless waste of water caused by defective fixtures, a house-to-house inspection was begun early last summer and has continued since. So far, the fixtures in 14,329 houses have been inspected; 4,946 houses were found with leaky fixtures and 4,556 contained closets without storage flushing tanks, the water being per-

CANAL DEAL BEAR

Details of the direct connection

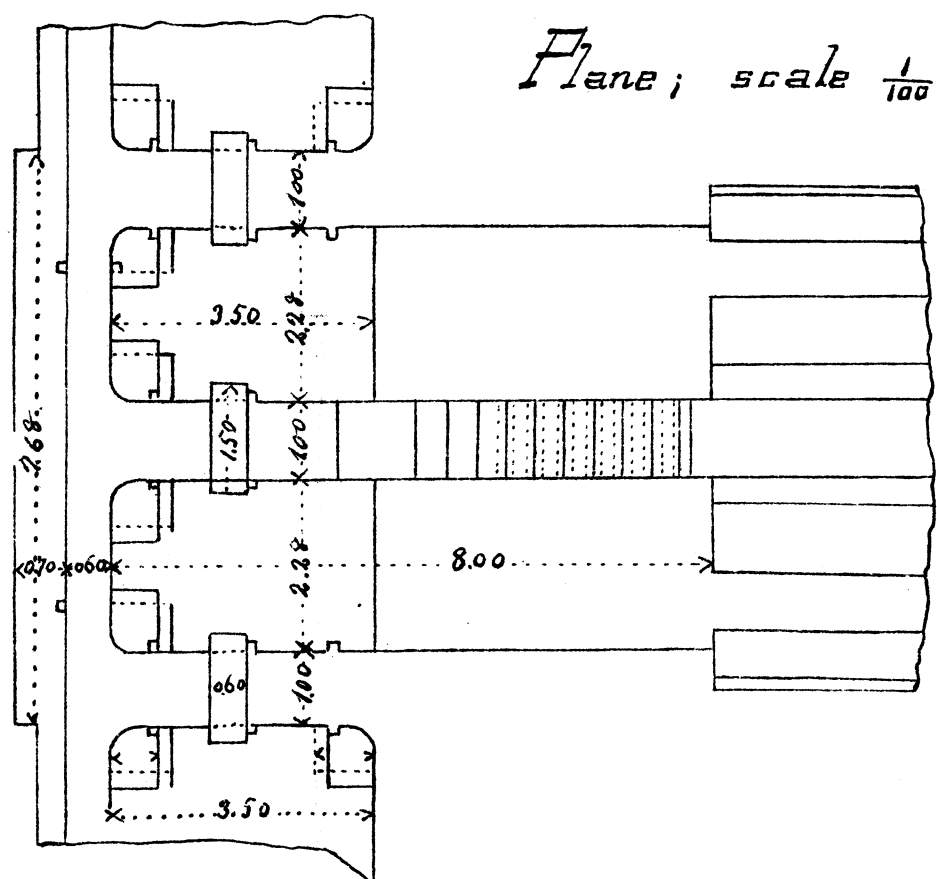


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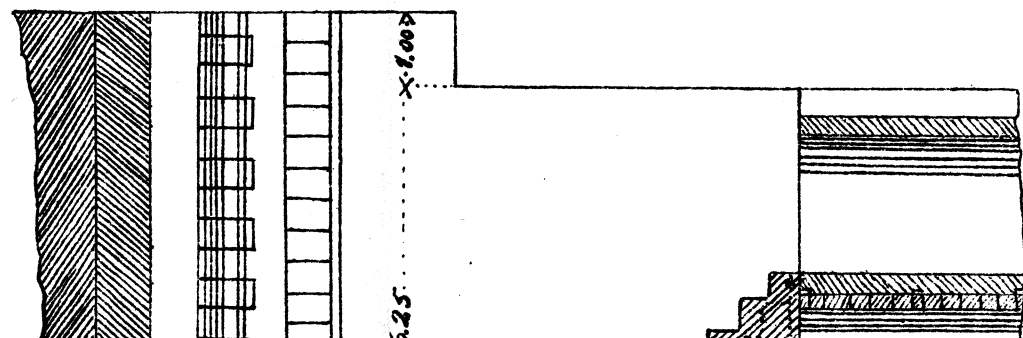
CANAL DE ALBEAR

WATER-RESERVOIR

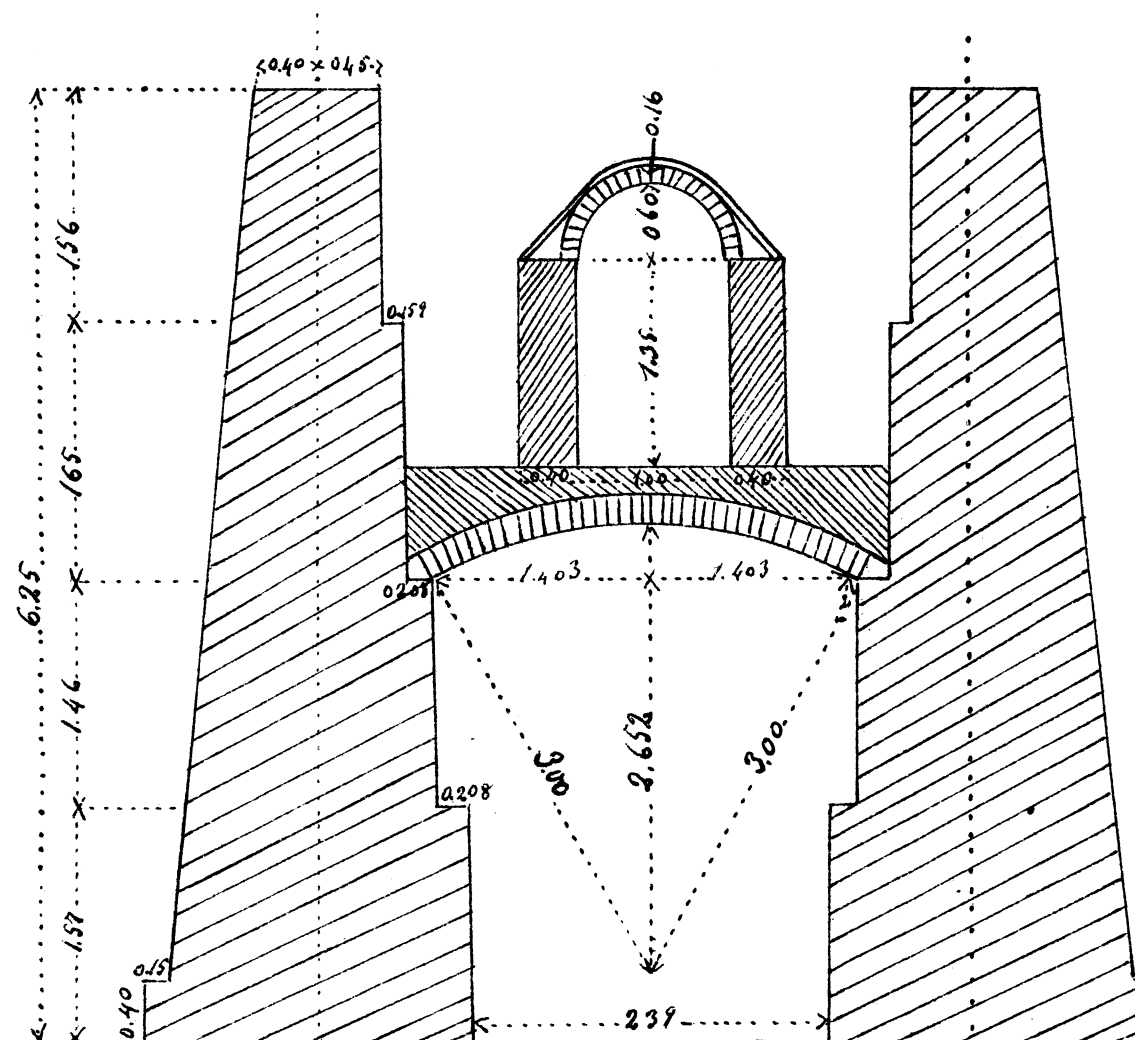
Details of the direct connection



Longitudinal section; scale $\frac{1}{100}$

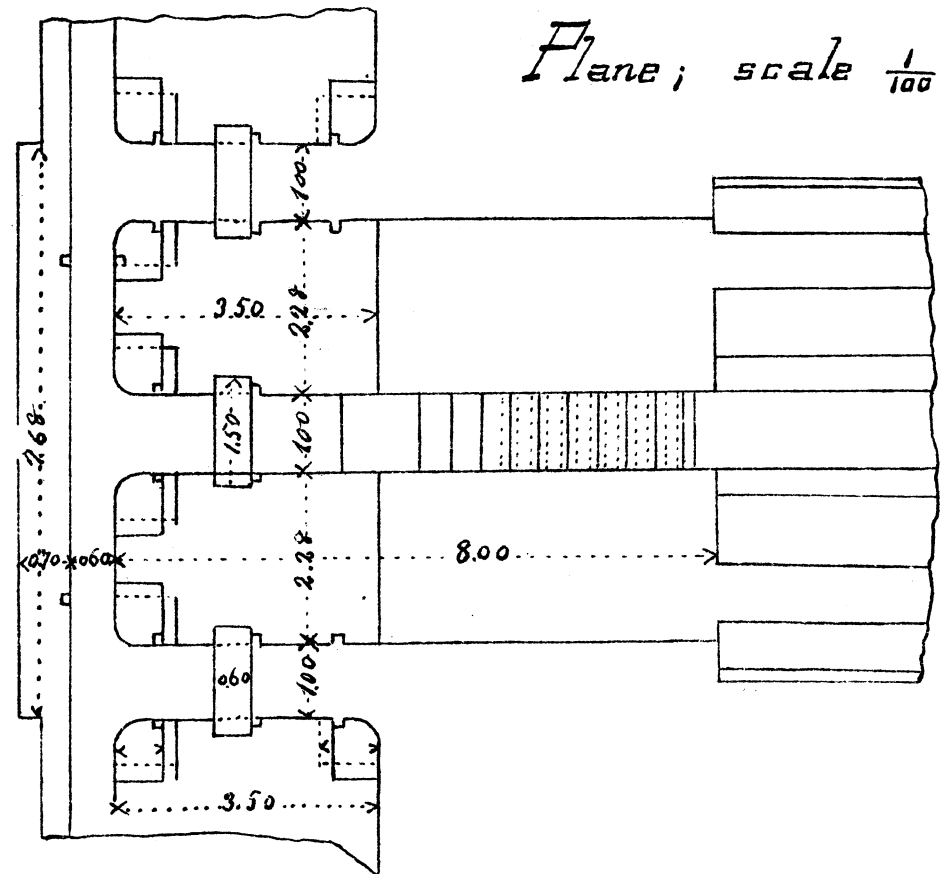


Transversal section; scale $\frac{1}{50}$

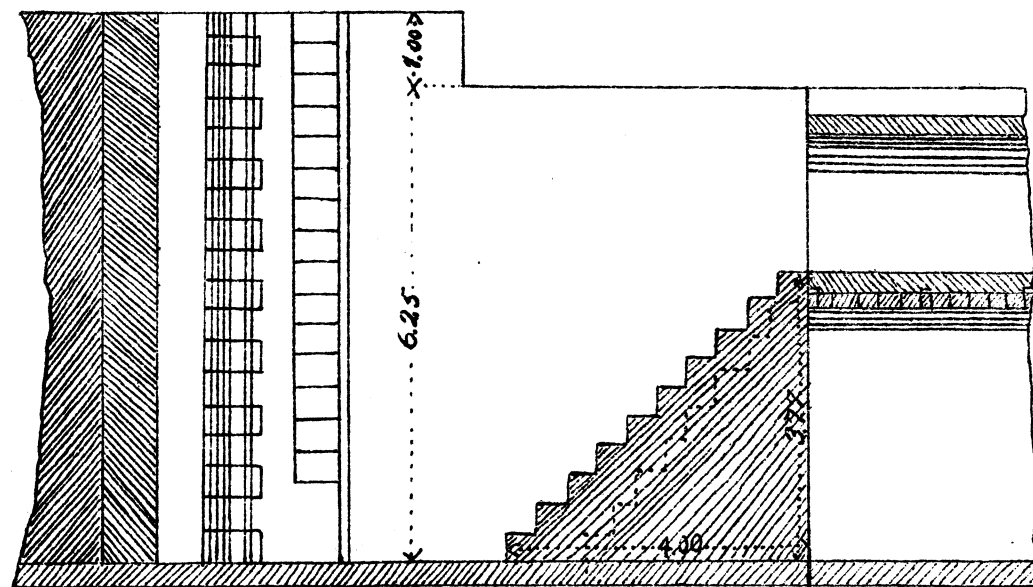


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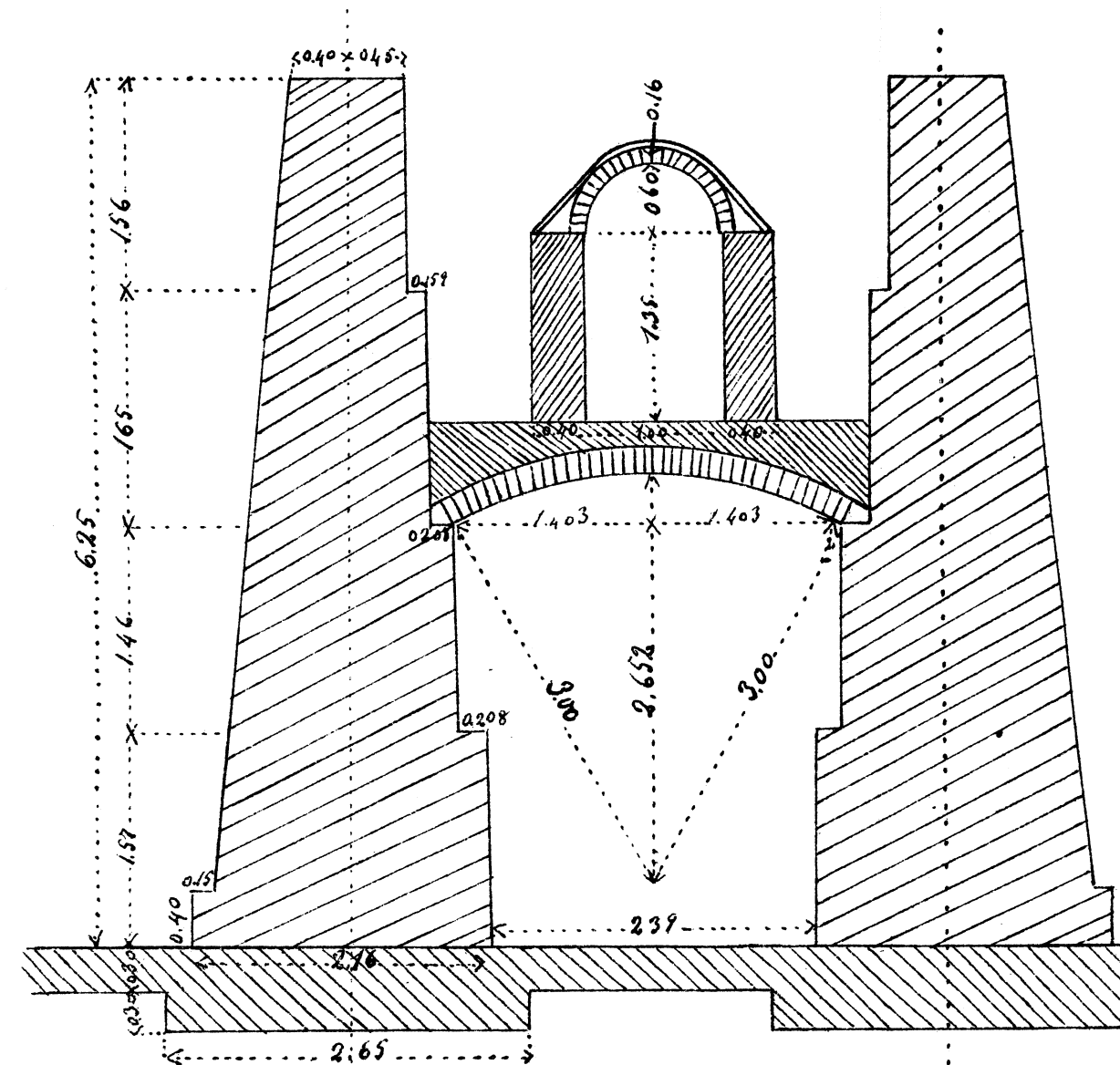
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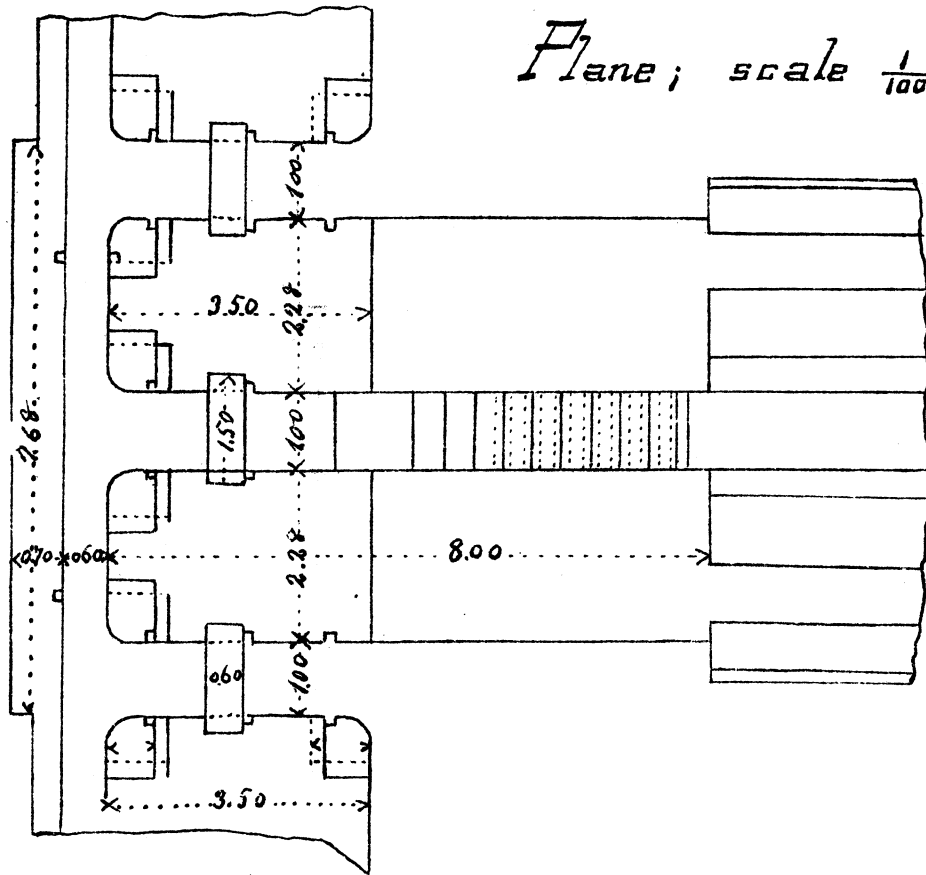
To accompany report of June 30th 1900

Major Corps of Engineers U.S. Army Chief Eng^r Division of Cuba

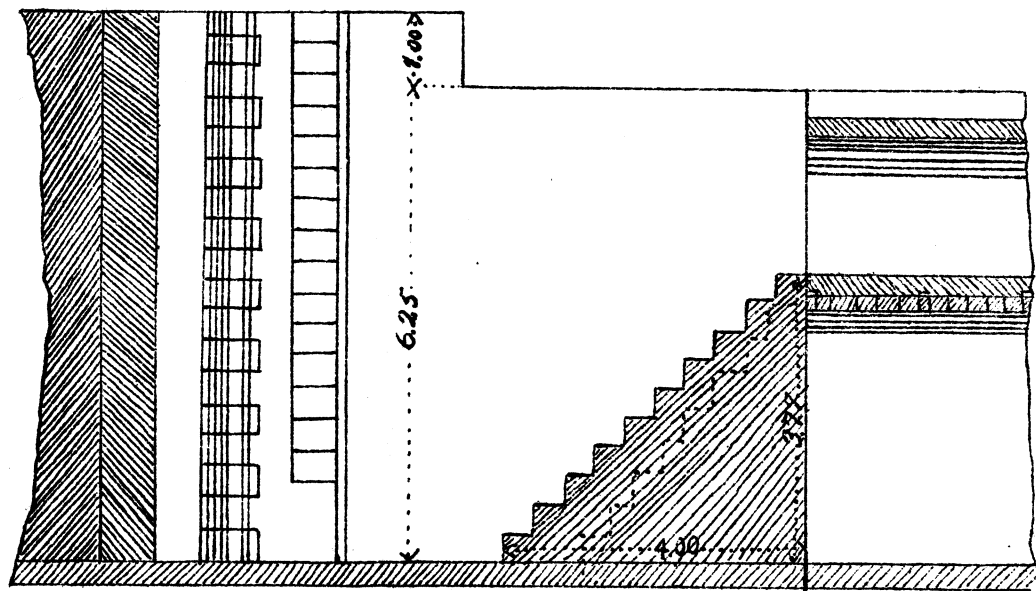
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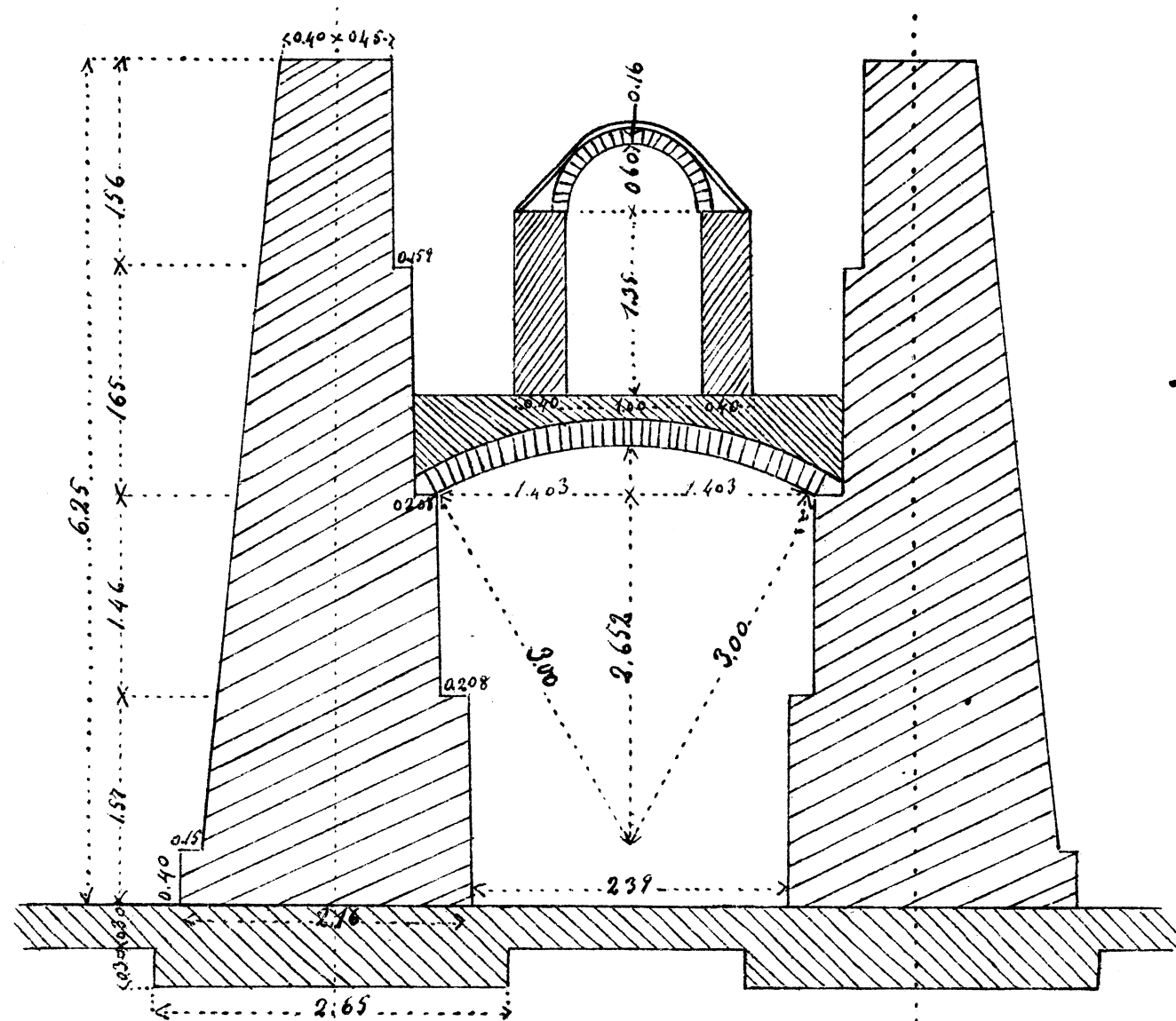
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Longitudinal section; scale $\frac{1}{100}$



Transversal section; scale: $\frac{1}{50}$



*Office of Chief Engineer
Division of Cuba.*

Division of Cuba.
To accompany report of June 30th 1900

Major Corps of Engineers U.S. Army Chief Eng^r Division of Cuba.

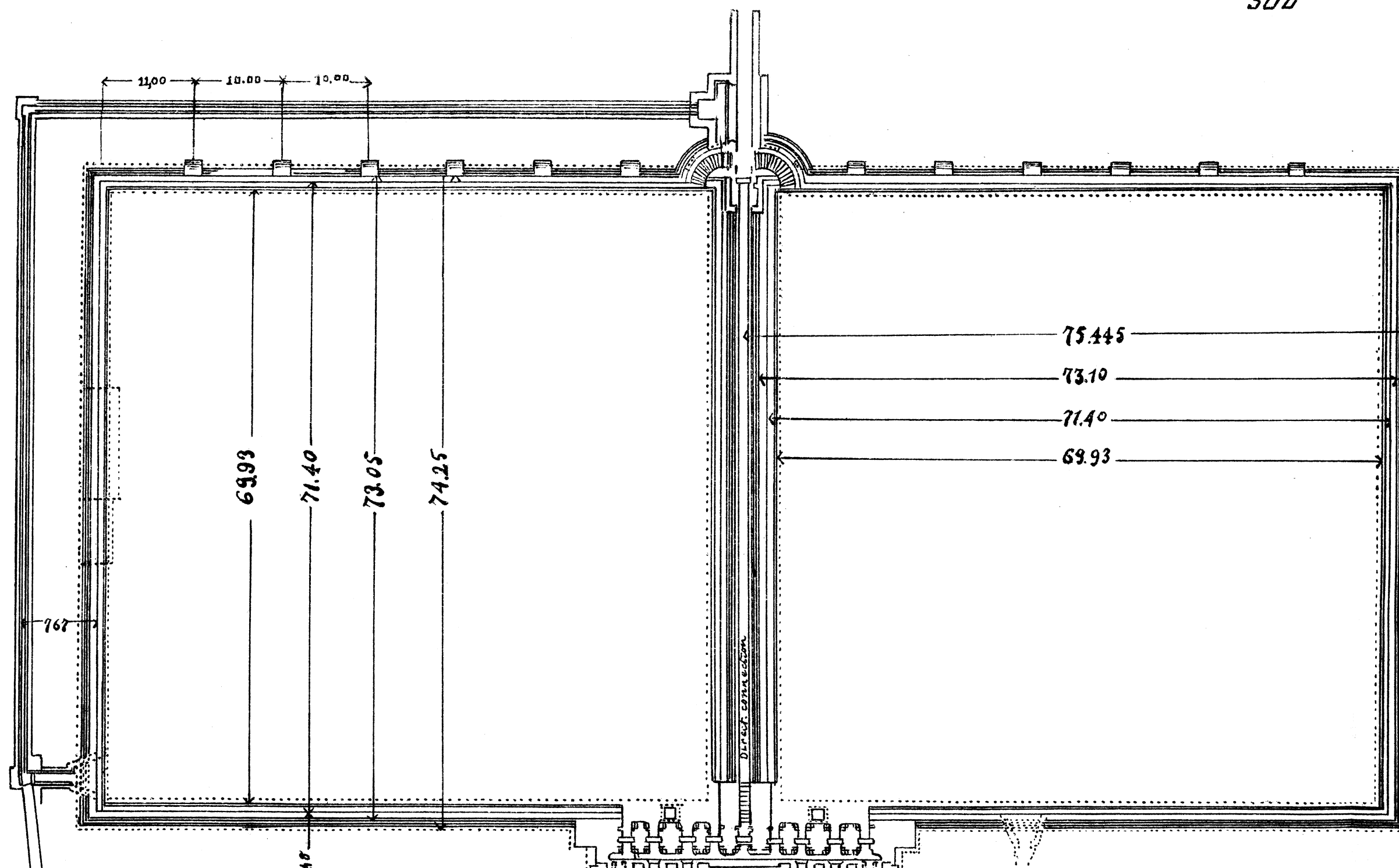


Office of Chief Engineer, City of Havana.

CANAL DE ALBEAR

WATER-RESERVOIR

Plane — scale $\frac{1}{500}$

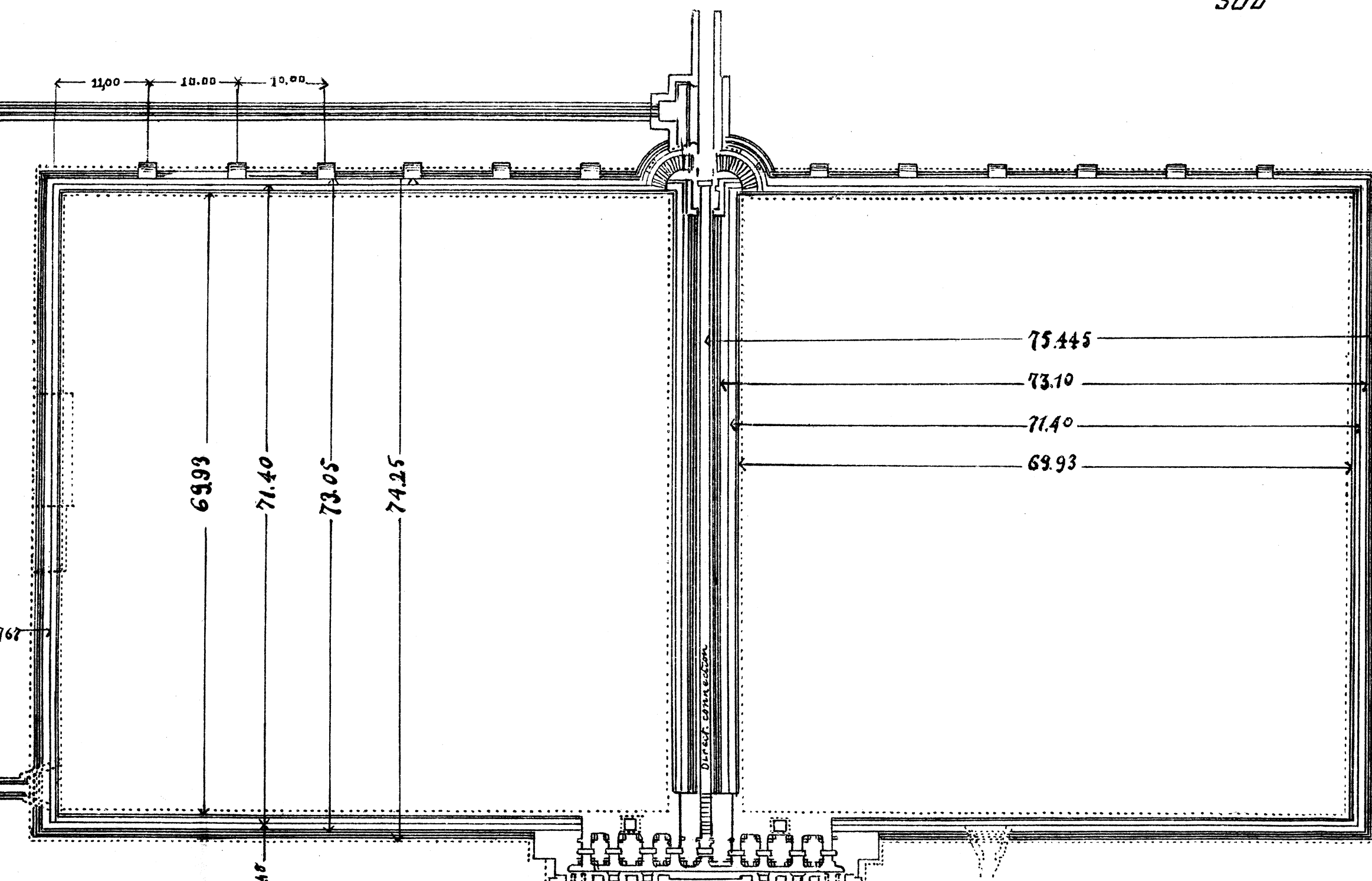


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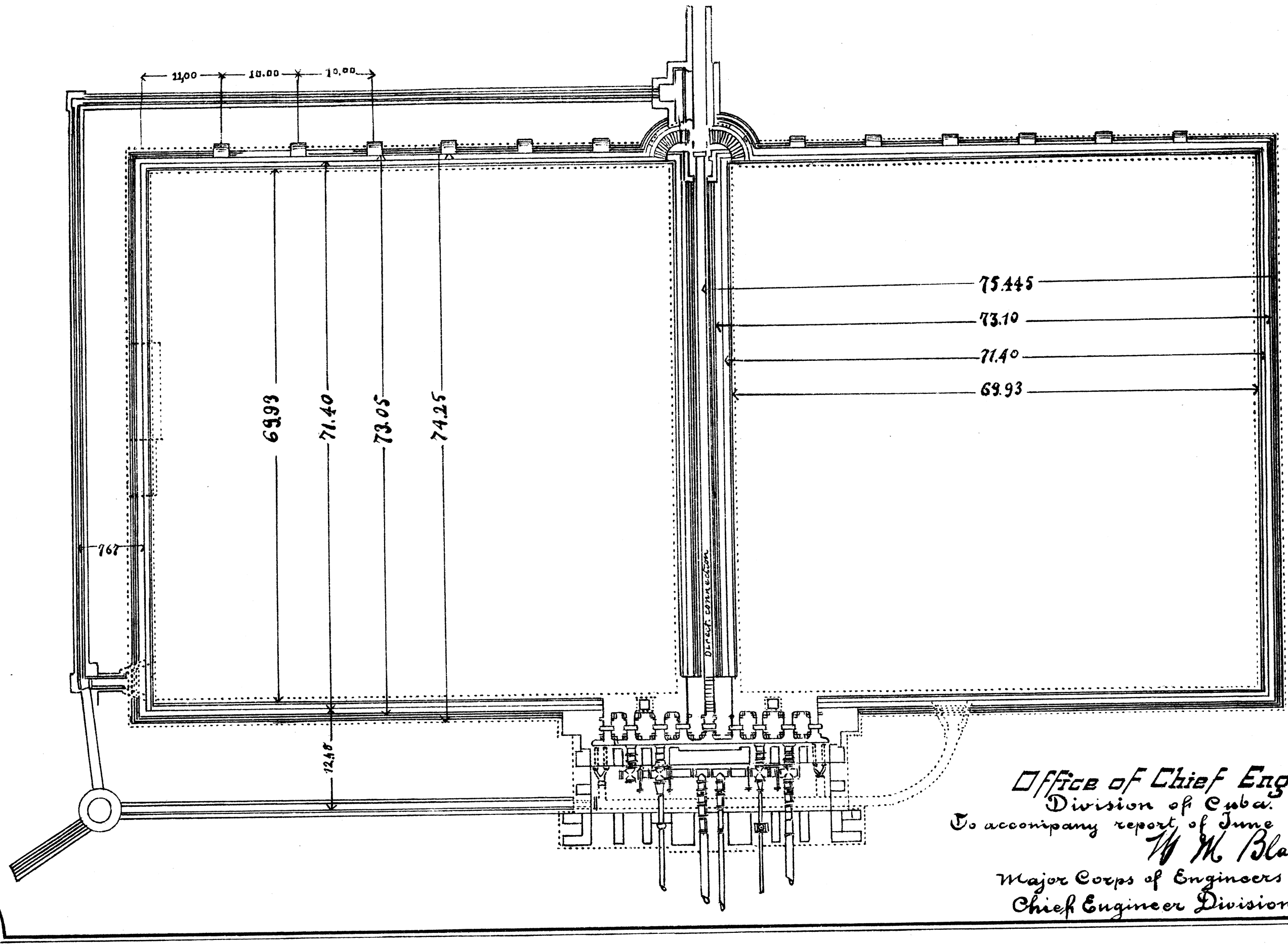
CANAL DE ALBEAR

WATER-RESERVOIR

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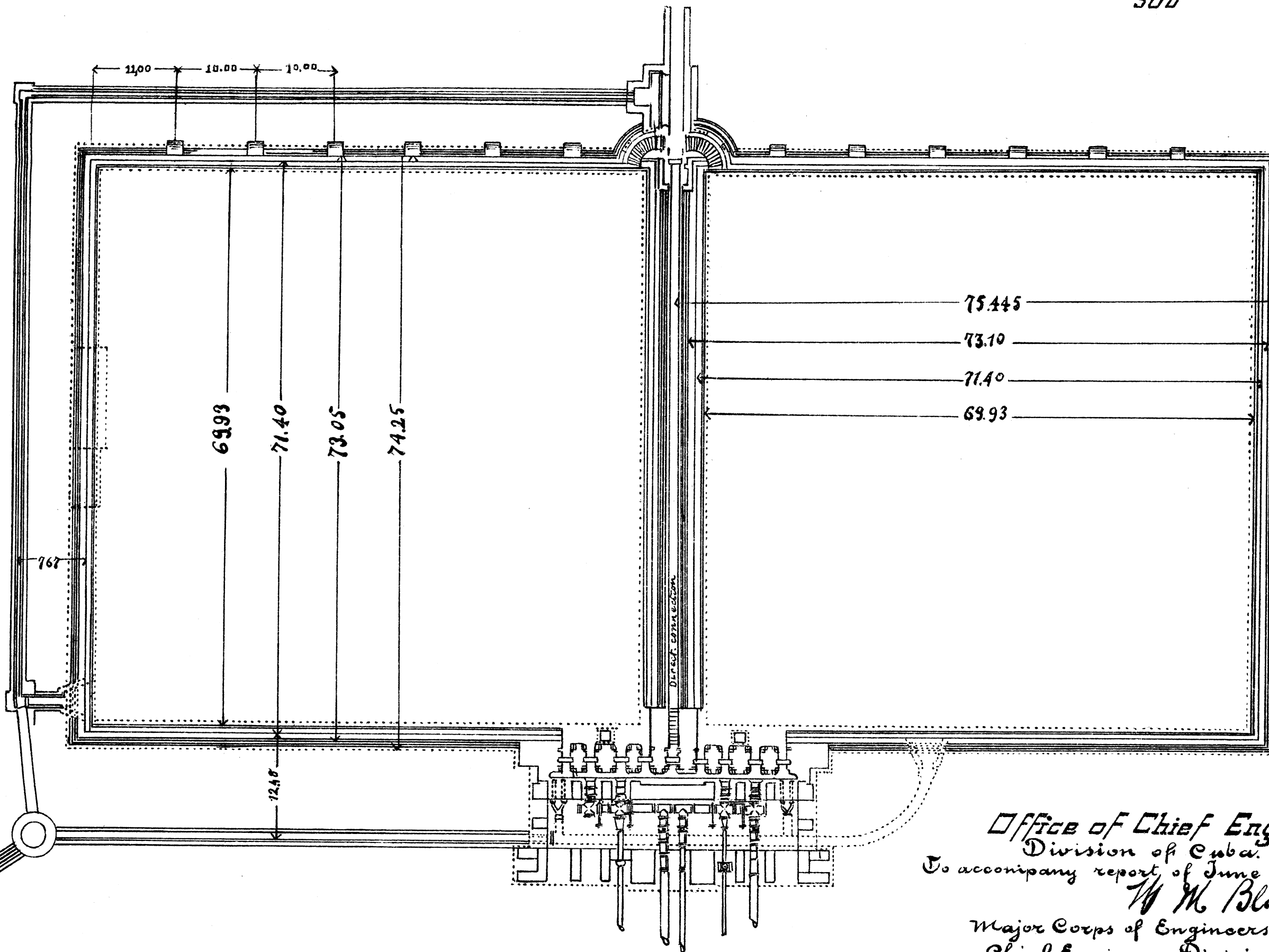


Plane — scale $\frac{1}{500}$



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Division of Cuba.
To accompany report of June 30
W. M. Black
Major Corps of Engineers U.S.A.
Chief Engineer Division

Plane — scale $\frac{1}{500}$



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Division of Cuba.
To accompany report of June 30th 1900.
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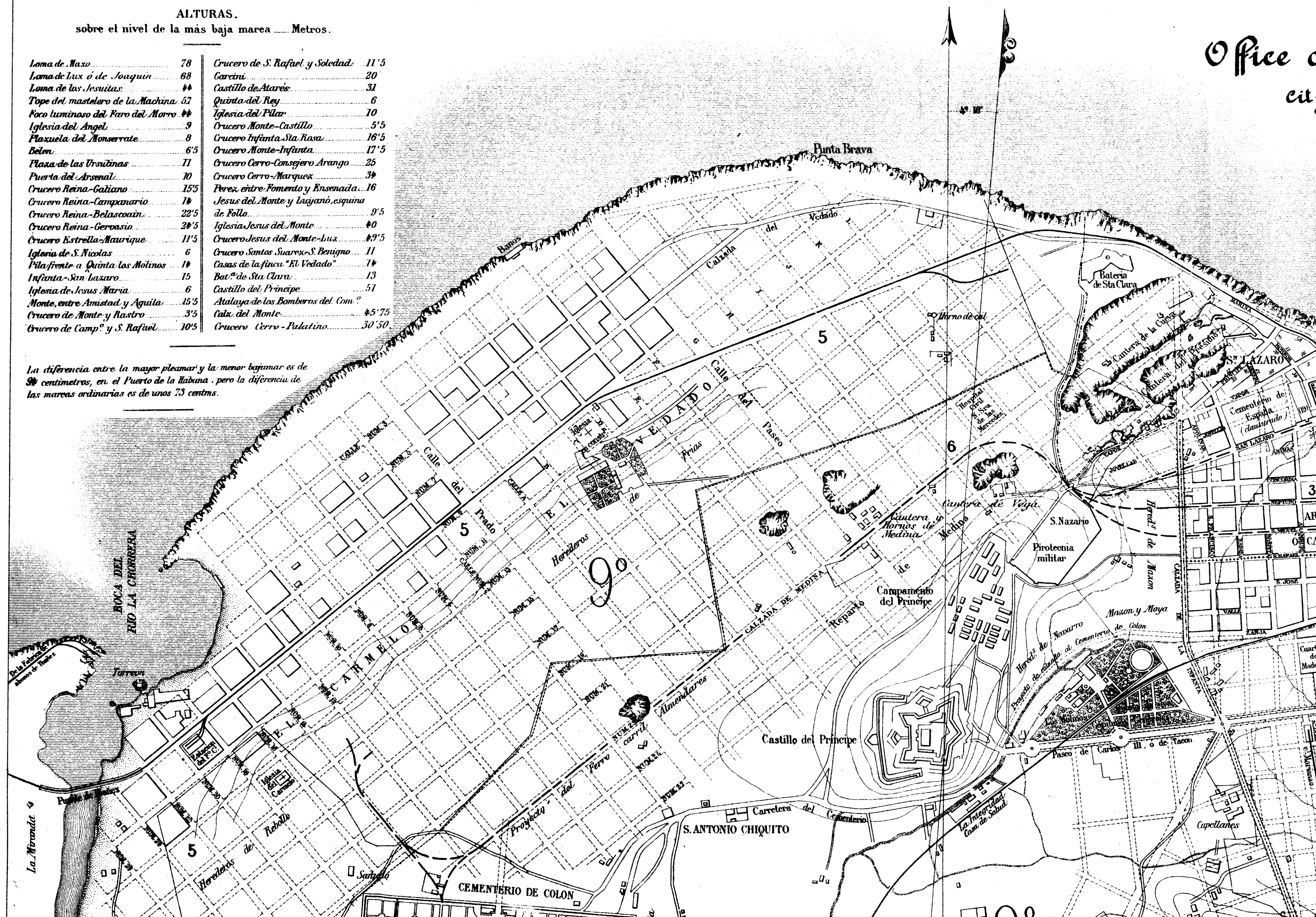


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| Loma de Lux ó de Jouguin | 68 | Garcini | 20 |
| Loma de los Jesuitas | 44 | Castillo de Atares | 31 |
| Tope del mastelero de la Machina | 57 | Quinta del Rey | 6 |
| Foro luminoso del Faro del Morro | 44 | Iglesia del Pilar | 10 |
| Iglesia del Angel | 9 | Crucero Monte-Castillo | 5'5 |
| Plaxuela del Monserrate | 8 | Crucero Infanta-Sta Rosa | 16'5 |
| Belen | 6'5 | Crucero Monte-Infanta | 17'5 |
| Plaza de las Ursulinas | 11 | Crucero Cerro-Consejero Arango | 25 |
| Puerta del Arsenal | 10 | Crucero Cerro-Marquez | 34 |
| Crucero Reina-Galiano | 15'5 | Perez entre Pomento y Ensenada | 16 |
| Crucero Reina-Campanario | 14 | Jesus del Monte y Luján, esquina | |
| Crucero Reina-Belascoain | 22'5 | de Follo | 9'5 |
| Crucero Reina-Gervasio | 24'5 | Iglesia Jesus del Monte | 40 |
| Crucero Estrella-Maurique | 11'5 | Crucero Jesus del Monte-Lux | 49'5 |
| Iglesia de S. Nicolas | 6 | Crucero Santos Suarez-S. Benigno | 11 |
| Pila frente a Quinta los Molinos | 14 | Casas de la finca "El Vedado" | 14 |
| Infanta-San Lazaro | 15 | Bat.ª de Sta Clara | 13 |
| Iglesia de Jesus Maria | 6 | Castillo del Principe | 51 |
| Monte, entre Amistad y Aguila | 15'5 | Atalaya de los Bomberos del Com.º | |
| Crucero de Monte y Rastro | 3'5 | Calx. del Monte | 45'75 |
| Crucero de Camp.º y S. Rafael | 10'5 | Crucero Cerro-Palutino | 30'50 |

La diferencia entre la mayor pleamar y la menor bajamar es de 94 centímetros, en el Puerto de la Habana, pero la diferencia de las mareas ordinarias es de unos 73 centms.

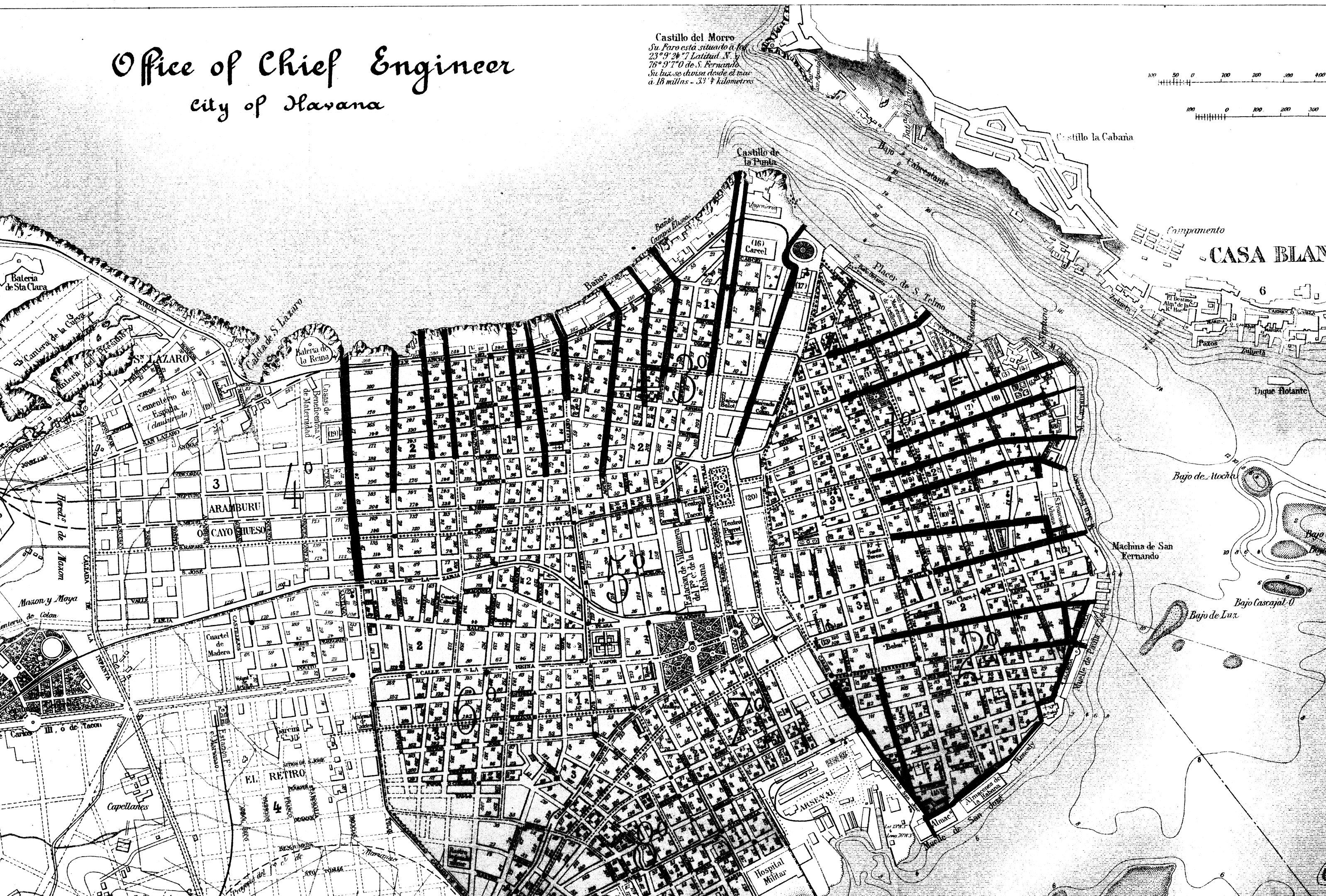
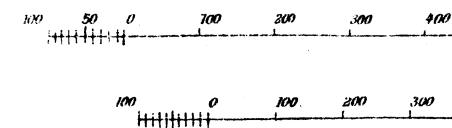


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Office of Chief Engineer

city of Havana

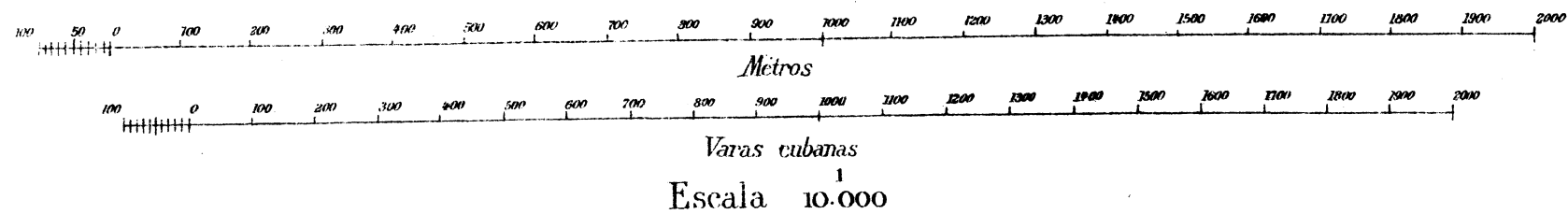
Castillo del Morro
Su Faro está situado a las
23° 9' 24" 7" Latitud N. y
76° 9' 7" 0" de S. Fernando
Su luz se chispa desde el mar
a 18 millas - 33 1/4 kilometros



Castillo del Morro
 Su Faro está situado a las
 23° 9' 24" N Latitud N.
 76° 9' 10" de S. Fernando
 Su luz se divisa desde el mar
 a 18 millas - 33 1/2 kilómetros

Castillo de la Punta
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PLANO

DE LA

HABANA

POR

D. ESTEBAN T. RICHARDO



9°

10°

Palatino

LUYANO

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CERRO

DEL MONTE

CONCHA

ENSENADA DE ATARES

EL RETIRO

BUENOS AIRES

Cayo Cruz
o Cayo Puto

Cayo Blanco

Almacén de pólvora
S. Antonio

Almacenes
de Hacendados

De la Compañía
del Ferro carril
de la Habana

Portas y Pinto

Abarex

Rio Luyano

Rendon

Puente de Pastrana

La Pma. Concepcion
de Concan

La Asuncion
de la Srta. viuda
Alvarez de la Campa
Arr. Pastrana

El Blanquizar

Garcia

Chico
o America
de D.M. de Embil

Pico y Aleman

Tejar

Compañia
de la Habana Gas Light

Rincon de
Melones

Julio Herrera

D. Pio

Ibey

Sra. Reinos

Portas

R. de Iglesias

R. de Caballero

R. de Rodriguez

R. de Perez

R. de Herrera

Reparto de Ojeda

Reparto de Sanjos

Reparto de Suarez

Reparto de E. Correa

Reparto de J. S. Briza

Reparto de D. Ant. Bachiller y Morales

Reparto de Chaple

Reparto de Sumarte

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PLANO DE LA HABANA

POR
D. ESTEBAN T. PICHARDO,

AGRIMENSOR Y MAESTRO DE OBRAS.

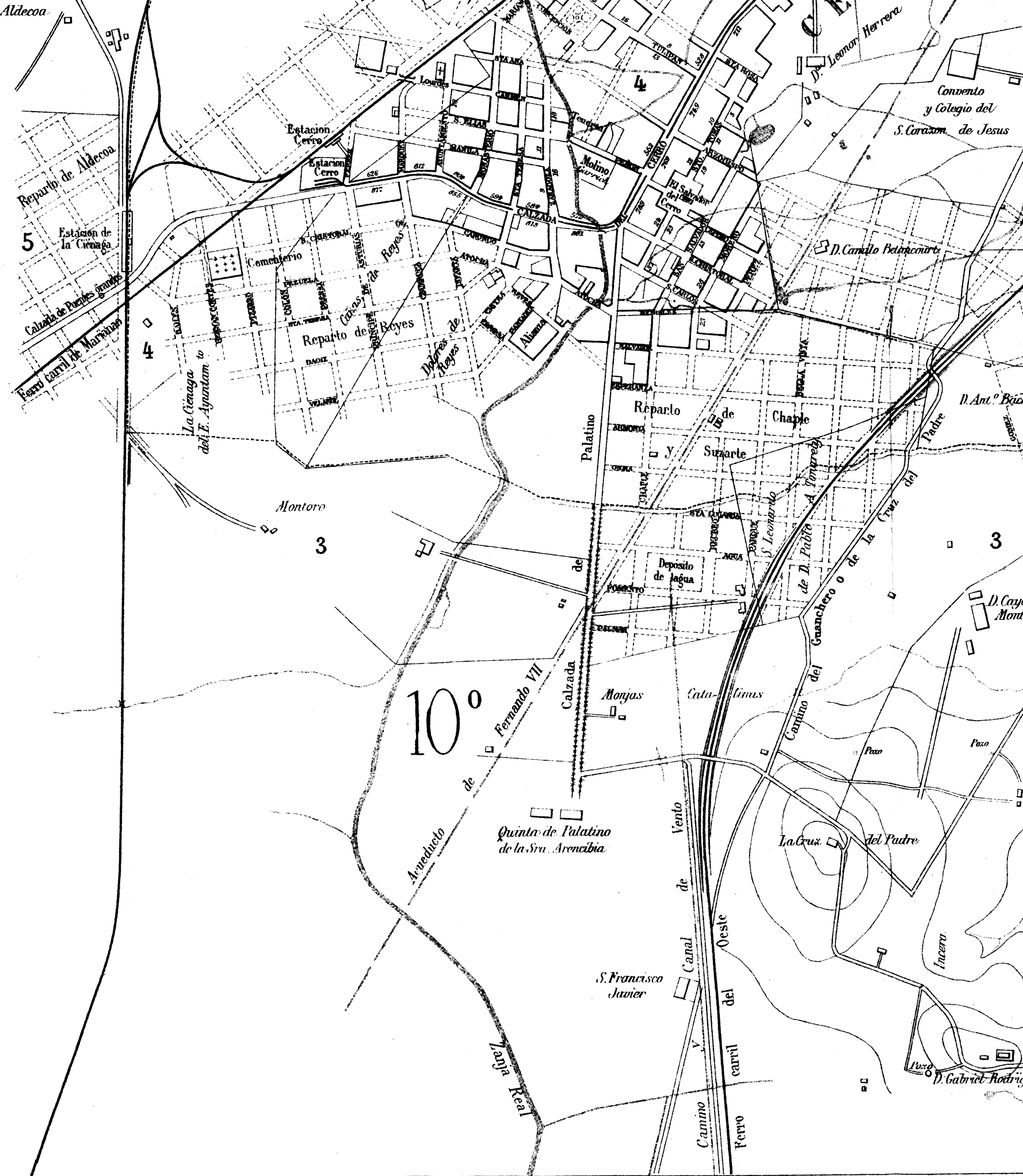
EDITOR: D. JOSÉ VALDEPARES.

Para la formación de este Plano, se han tenido presentes: el publicado por el Excmo. Ayuntamiento, el del Puerto por los Ingenieros de Obras públicas y otros debidos a los Sres. D. Mariano Carles, D. José Ocampo, D. J. Manuel Alvaro, D. Alberto de Castro, D. Antonio Ariza, D. José Lopez Trigo, D. José C. del Castillo, D. Simon Teja &c; cuyos trabajos ha combinado el Autor del presente, añadiendo los que practico expreso sobre el terreno.

Las curvas de igual sonda, dibujadas en el Puerto, indican la profundidad del agua de dos en dos metros, en baja mar, y están deducidas del sondeo verificado por O. públicas en 1874.

- Estac. telegráfica
- Caja de agua
- Caja y sifón
- Sifón
- Ferrocarril en explotación
- Idem en proyecto
- Parroquia
- Limite Municipal
- Idem de Distrito municipal
- Idem de Barrio
- Idem de Parroquia

Los números de las casas corresponden al último de cada frente de manzana y están escritos en carácter italico, como 1, 2, 3, &c.
Los que se refieren a la numeración del Directorio, están escritos en carácter romanos, y entre paréntesis: (1) (2) (3) (4)
Los ordinales de los Distritos municipales son de carácter capitales y tamaño grande: 1º
Los de los barrios son de carácter romano, mayores que los del Directorio: 1, 2, 3



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mitted to flow constantly in the bowl of the closet, thus consuming an excessive quantity of water without attaining the object of flushing or giving satisfactory sanitary results. Fines have been imposed where it was found that the occupants were not disposed to remedy the defects as stated. This method of abating the waste of water has produced, in a measure, good results; but has not altogether accomplished all that the importance of the question demands.

Although the waste of water has been decreased considerably, there is still much work to be done in order to attain the desired end in this branch of the public service.

The present city ordinance is wholly inadequate for the control and regulation of the water service. A draft of a new water ordinance has been prepared for the purpose of granting the department better control over the service. The proposed ordinance is based on the modern practices adopted in American cities governing water consumption. The water rates as now fixed are divided into only two yearly amounts, namely, \$20 and \$40. The former rate applies to houses producing rentals of \$32 or less monthly and the latter rate to houses yielding any amount above \$32 monthly. The proposed new rates contemplate a reduction of the present charges to small consumers, and to increase the charges to the large consumers. It is provided that establishments requiring an extra quantity of water shall be connected with a meter, paying for the actual quantity of water consumed at the rate of 4 cents per cubic meter.

It is estimated that the proposed new rates will furnish an ample surplus of funds above the bonded indebtedness and maintenance, besides sufficient funds to liquidate all expenses in connection with the extension of the general system of mains; in other words, the income or revenue from the water collection will wholly maintain the department and provide an ample sinking fund to gradually pay off all bonded indebtedness.

All government and municipal buildings have been furnished with new water fixtures and sanitary plumbing.

New drains and plumbing were installed or the old systems modified (as the case required) in 930 houses, to conform to the latest sanitary practices. Owing to the small number of main sewers of proper form in the streets, the modification of sanitary fixtures is necessarily curtailed. In all new structures, however, the latest plumbing improvements and devices are followed, the work being so arranged that connection can be readily made with the main sewers in the near future.

The following is a summation of other work performed by the department during the year, viz: Completion of work of repair at Vento; partial repair of dam near filter beds; 2,367 reported breaks in service pipes inspected and repairs made in 1,998 cases; 37 new fire hydrants installed; eleven 3-inch, ninety-four 4-inch, thirteen 8-inch, one 12-inch, and one 20-inch valves installed; many minor installations and extensions of distribution mains, amounting in all to 105,792 linear feet of pipe of all sizes; the periodical cleaning and repairs of the reservoirs and of the Zanja Real; cleaning and repair of the Vento aqueduct and its appurtenances; installation of a telephone line between Palatino and Vento.

Work done by water survey department.

| | | | |
|------------------------------------------------|---------|---------------------------------------------------------------------------------------------|--------|
| Number of houses inspected..... | 14, 329 | Number of flush tanks installed in closets which formerly had constantly running water..... | 4, 711 |
| Number of leaks found..... | 4, 946 | Number of notices sent to owners..... | 7, 983 |
| Number of water-closets without tanks..... | 4, 556 | Number of tanks without valves..... | 10 |
| Number of houses without stop cocks..... | 2, 398 | Average increase of water pressure throughout the city..... | 3. 70 |
| Number of houses taking water from others..... | 883 | Number of sanitary plumbing inspections..... | 3, 546 |
| Number of houses without water..... | 2, 248 | Number of houses in which plumbing has been modified..... | 2, 356 |
| Number of houses reinspected.... | 5, 026 | Number of new houses in which modern plumbing has been introduced throughout..... | 112 |
| Number of house services turned off..... | 441 | | |
| Number of house services turned on..... | 322 | | |

SEWER DEPARTMENT.

On January 1, 1899, when the government of Habana passed under American control the present engineer department was organized.

The department of sewers was fairly started during the latter part of February following. No records of data were found in the archives of the municipality relating to a plan, size, location, or form of construction of the existing sewers. In order to learn the location and details of the construction of the main sewers excavations were made in order to expose all the underground work. Sewers were found in many of the streets, most of them more or less obstructed with accumulations of deposits. Those found in this condition were opened at convenient points to admit of the entrance of workmen with scrapers to remove the deposits. As there were no manholes, the pavement and the crown of the sewer were removed to facilitate the work of cleaning; also to secure correct data in regard to the size, construction, and other details of the sewers. The data thus collected has been plotted, affording the department a plan of the existing sewers.

The plan develops the fact that no general system was followed; but in nearly all cases each main sewer was laid to a grade to meet the requirements of the abutting property. An outlet was obtained at the nearest and most convenient point. Owing to this promiscuous method of construction many localities are deprived of an outlet on account of the grades and sizes of the sewers, being either too high or too small to permit the required extension.

Many of the sewers are rectangular in form. The sides and top are constructed of dimension coral stone. The mortar between the joints has disintegrated, the bottoms of some of the sewers are without lining, and the sewage is in contact with the earth, which of course absorbs more or less of the contents flowing through the sewers. The contamination of the adjoining soil with sewage is made excessive by the flat grades of the sewers.

The essential and important work of preparing a plan of main drainage was undertaken to meet the requirements of the city for all time, based upon the best practice governing this class of work. With this object in view a city datum line was established and referred to the mean low tide and seven substantial concrete monuments placed below the surface of the ground at prominent points in the city. These elevations were correctly established in relation to the datum plane. Several parties were placed in the field to take the levels of all the

streets and vacant lands within the limits of the drainage area of the city. These levels and corresponding profiles were completed in June, 1899.

During the progress of this work automatic gauges were placed to record the tidal rise and fall of the Gulf and the bay. One gauge was placed to record the action of the tides of the Gulf, another inside and near the mouth of the harbor, and a third near the head of the bay. The gauges are still installed and a daily register of the tides is being kept, thus extending the observations for a period of twelve months, in order to determine definitely the true level of mean low tide.

In May, 1899, operations were inaugurated to observe the direction and action of the currents of the bay and Gulf, under the various conditions existing during a period of three months, by means of surface, subsurface, and rod floats. A base line was located along the coast line for observing the action of the floats. The floats were placed daily at points along a distance of 5 miles and outward 1,500 feet, including the area in which it was thought to be possible to discharge the sewage. During heavy rains and stormy weather a seagoing tug was required to place and follow the floats; during calm weather small boats were used. The direction and velocity of the winds were taken at the same time. All the data obtained during these observations have been properly plotted for reference, with a view of determining the final effect of discharging the sewage of Habana into the Gulf of Mexico.

Soundings indicate very deep water a short distance from shore. At many points, a thousand feet from shore, the depth is 300 feet, growing rapidly deeper as the distance is increased.

Upon completion of these investigations, Mr. D. J. McComb, superintendent of sewers of the city of Washington, D. C., was engaged as consulting engineer. Mr. McComb arrived in Havana on July 17, 1899, for the purpose of giving the department the benefit of his long experience as a sewer expert in developing a general scheme for a sewerage system. He devoted four months to investigating the question and preparing a report. The employees of the office, engaged in the preliminary work, were placed under his control to facilitate the work of investigation and aid him in the general undertaking.

In November Mr. McComb completed a report and plan. His plan provided for sewers for all of the built-up portions of Habana, including Cerro, Jesus del Monte, and Vedado, with sewer dimensions sufficient to permit the building up of all the intermediate spaces, so as to provide for a population of 500,000 people. Sewage from all of the higher ground is carried by a system of laterals, submains, great mains, and interceptors, by gravity to a central station, to be situated at a proper point near the harbor entrance. Sewage from the low ground of the Jesus del Monte and Cerro wards and the neighborhood of the gas house to be carried to a secondary pumping station, to be pumped through a force main to a higher level interceptor. From the central station all sewage is to be carried across the harbor to a pumping station there and elevated sufficiently to be discharged by gravity to a point east of the Morro.

The plan also provides for storm water sewers, in such localities as they may be needed, no sewage to be permitted to enter the bay.

It is estimated that the total cost of the system, covering the entire city as built up to-day, will not exceed \$5,000,000.

A series of borings were taken across the harbor, at various points, in order to determine the relative levels of the mud and rock, so that the best line for crossing the harbor could be fixed upon.

This plan was then submitted to Mr. Samuel M. Gray, consulting engineer, of Providence, R. I., who was selected as the best authority that could be obtained for this purpose. Mr. Gray arrived in Habana December 18, 1899, and remained for two months, during a portion of which time his assistant, Mr. Leland, was also in the city. The time was spent in a careful study of the ground, in connection with Mr. McComb's report and plan. Since his return to the States, Mr. Gray has been preparing detailed plans for his final report and estimates. Mr. Gray's report, together with plans showing the general features of the sewerage and drainage system, is included in this report.

Near the end of November, 1899, the project of Mr. M. J. Dady, of New York, for a sewerage system for Habana, was sent to the department for examination and report. Mr. Dady's original project had been submitted to the Spanish authorities in 1895, and a modification of this project in 1897, and had been under consideration since those dates. The project was carefully examined, and in December, the chief engineer being then in the United States on temporary duty, the following report on the commercial side of the project was submitted by Mr. P. D. Cunningham, acting chief engineer:

REPORT ON DADY PROPOSAL.

In the spring of 1895, Michael J. Dady & Co. submitted to the city of Habana their original project for sewerage and pavement of that portion of the city to the east of and including Belascoain Street, and the pavement of portions of Calzadas of Cerro and Jesus del Monte.

The project comprised: First, the removal of domestic and manufacturing sewage; second, the final disposal of sewage; third, the drainage of the subsoil; fourth, the disposal of storm water; fifth, the paving of the streets.

The project for sewerage contemplated the collection of all sewage at a point in the vicinity of Calzada de Vives, between Figuras street and Matadero Creek; the construction at that point of a chemical reduction plant; erection of a crematory, and the discharge of the effluent into the bay.

The method of disposal was disapproved by the representatives of the Spanish Government.

May 26, 1897, the same firm submitted to the city a second project for sewerage and pavement, which was the same as the original with different disposal. This proposition provided for a "partly separate system of sewers." (1) A system of sewers for conducting the domestic and manufacturing waste, (2) a system for a portion of the storm water from the streets, (3) a system for subsoil drainage.

System 1 was said to be calculated for a population of 300,000 inhabitants, using 25 gallons of water per head per day. Sewers of 24 inches in diameter or less to be of vitrified clay pipe. Larger sewers to be of masonry of ovoid section. House connections to be made from the sewers to within a meter of the outside walls of the house. The sewage carried by this system to be pumped through pipe line to a point 2 kilometers east of Cojimar, a distance from the collecting basin and pumping station of about 7 miles.

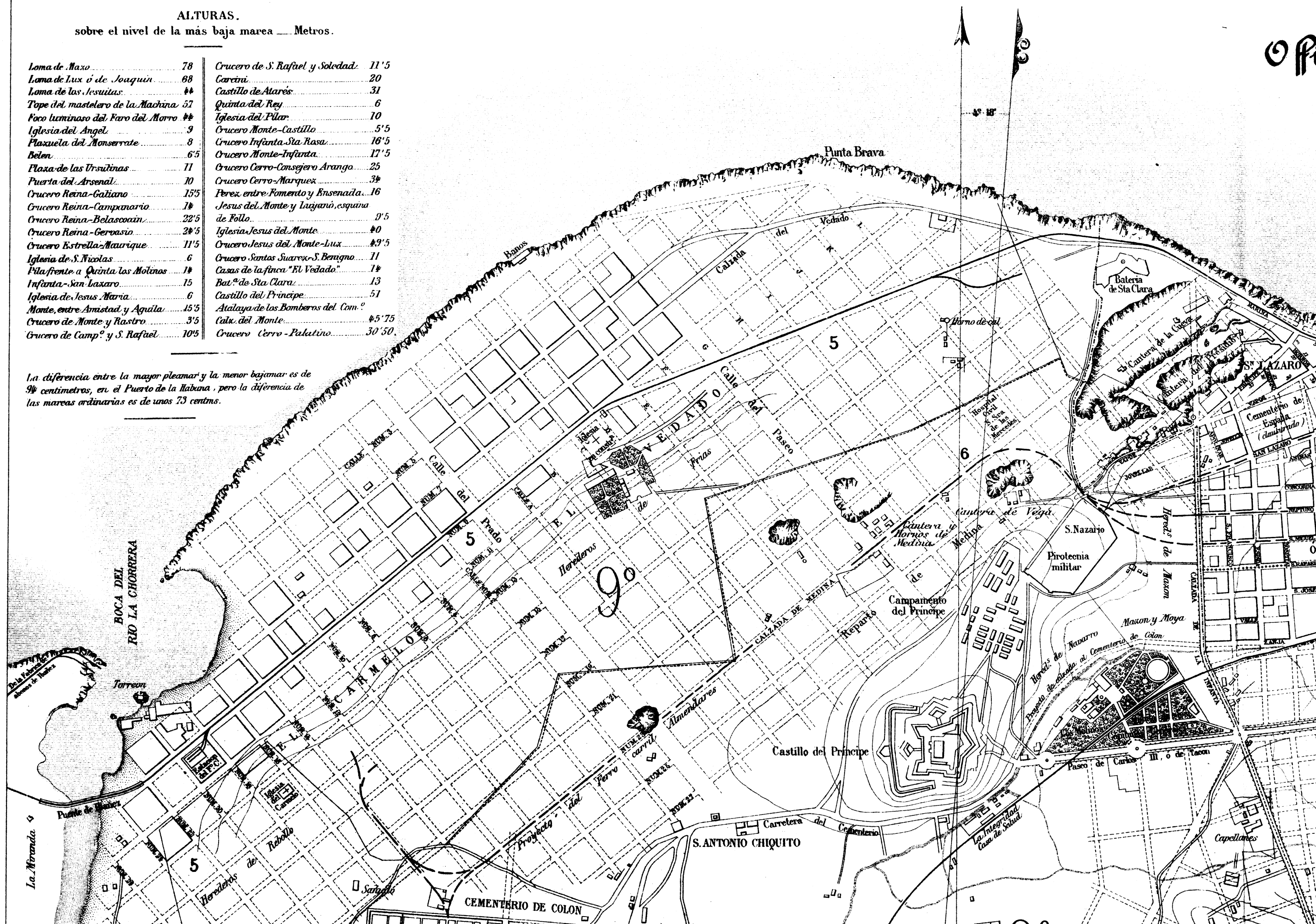
There is nothing in the records of the matter to show why it was deemed necessary to go so far from the base to dispose of the sewage. System 1 provides for 92,857 meters of vitrified clay pipe sewer varying in diameter from 20 to 60 centimeters, main sewers of masonry varying in diameter from 60 by 90 centimeters to 1.2 by 1.8 meters, 5,350 meters; length of force mains, 12,000 meters.

This project did not provide in any way for sewerage of Cerro, Jesus del Monte, or Vedado, and the sewage now emptied into the bay by Matadero Creek would not be otherwise cared for. Storm sewers to be placed in the same ditch with the sewage conduits, but at a greater height; to be of vitrified clay pipe of uniform diameter, of 24 inches. This is assumed to provide for a rainfall of half cubic meter per hectare per hour, equivalent to a film of water, during that time, 0.002 of an inch in depth. The storm water to be emptied partly into the gulf and partly into the bay. Total length of storm sewers, 14,517 meters. Subsoil drains to be made of porous clay pipe,

ALTURAS.
sobre el nivel de la más baja marea — Metros.

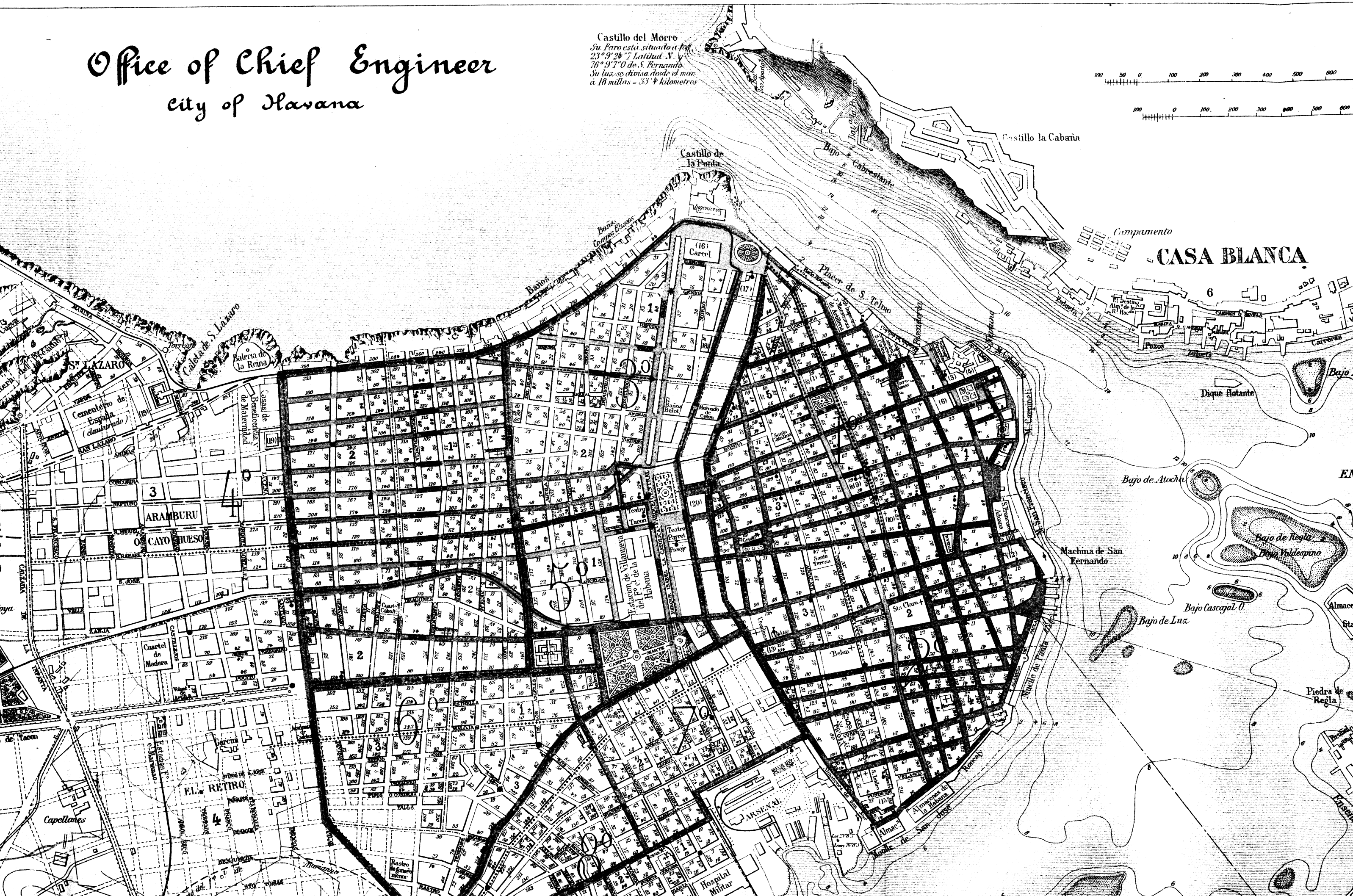
| | | | |
|----------------------------------|------|--------------------------------------------|-------|
| Loma de Maxo | 78 | Crucero de S. Rafael y Soledad | 11'5 |
| Loma de Lux o de Jouquin | 68 | Carini | 20 |
| Loma de las Jesuitas | 44 | Castillo de Alarés | 31 |
| Tope del mastelero de la Machina | 57 | Quinta del Rey | 6 |
| Foco luminoso del Faro del Morro | 44 | Iglesia del Pilar | 10 |
| Iglesia del Angel | 9 | Crucero Monte-Castillo | 5'5 |
| Plazuela del Monserrate | 8 | Crucero Infanta Sta. Rosa | 16'5 |
| Belen | 6'5 | Crucero Monte-Infanta | 17'5 |
| Plaza de las Ursulinas | 11 | Crucero Cerro-Consuegro Arango | 25 |
| Puerta del Arsenal | 10 | Crucero Cerro-Marquez | 34 |
| Crucero Reina-Galiano | 15'5 | Perez entre Fomento y Ensenada | 16 |
| Crucero Reina-Campanario | 14 | Jesus del Monte y Lujano, esquina de Follo | 9'5 |
| Crucero Reina-Belascoain | 22'5 | Iglesia Jesus del Monte | 40 |
| Crucero Reina-Gervasio | 24'5 | Crucero Jesus del Monte-Lux | 49'5 |
| Crucero Estrella-Maurique | 11'5 | Crucero Santos Suarez-S. Benigno | 11 |
| Iglesia de S. Nicolas | 6 | Casas de la finca "El Vedado" | 74 |
| Pila frente a Quinta los Molinos | 14 | Bat.º de Sta Clara | 13 |
| Infanta-San Lazaro | 15 | Castillo del Principe | 51 |
| Iglesia de Jesus Maria | 6 | Atalaya de los Bomberos del Com.º | |
| Monte, entre Amistad y Aguila | 15'5 | Calx. del Monte | 45'75 |
| Crucero de Monte y Rastro | 3'5 | Crucero Cerro-Palatino | 30'50 |
| Crucero de Camp.º y S. Rafael | 10'5 | | |

La diferencia entre la mayor pleamar y la menor bajamar es de 94 centímetros, en el Puerto de la Habana, pero la diferencia de las mareas ordinarias es de unos 73 centms.

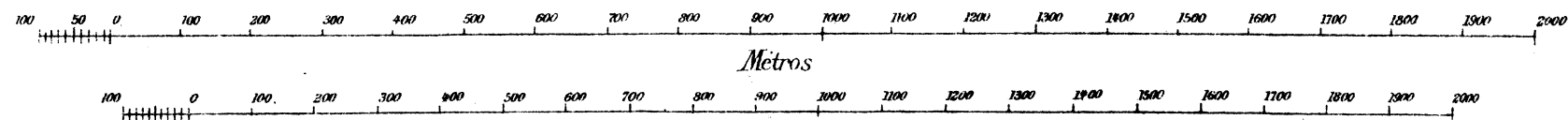


Office of Chief Engineer
city of Havana

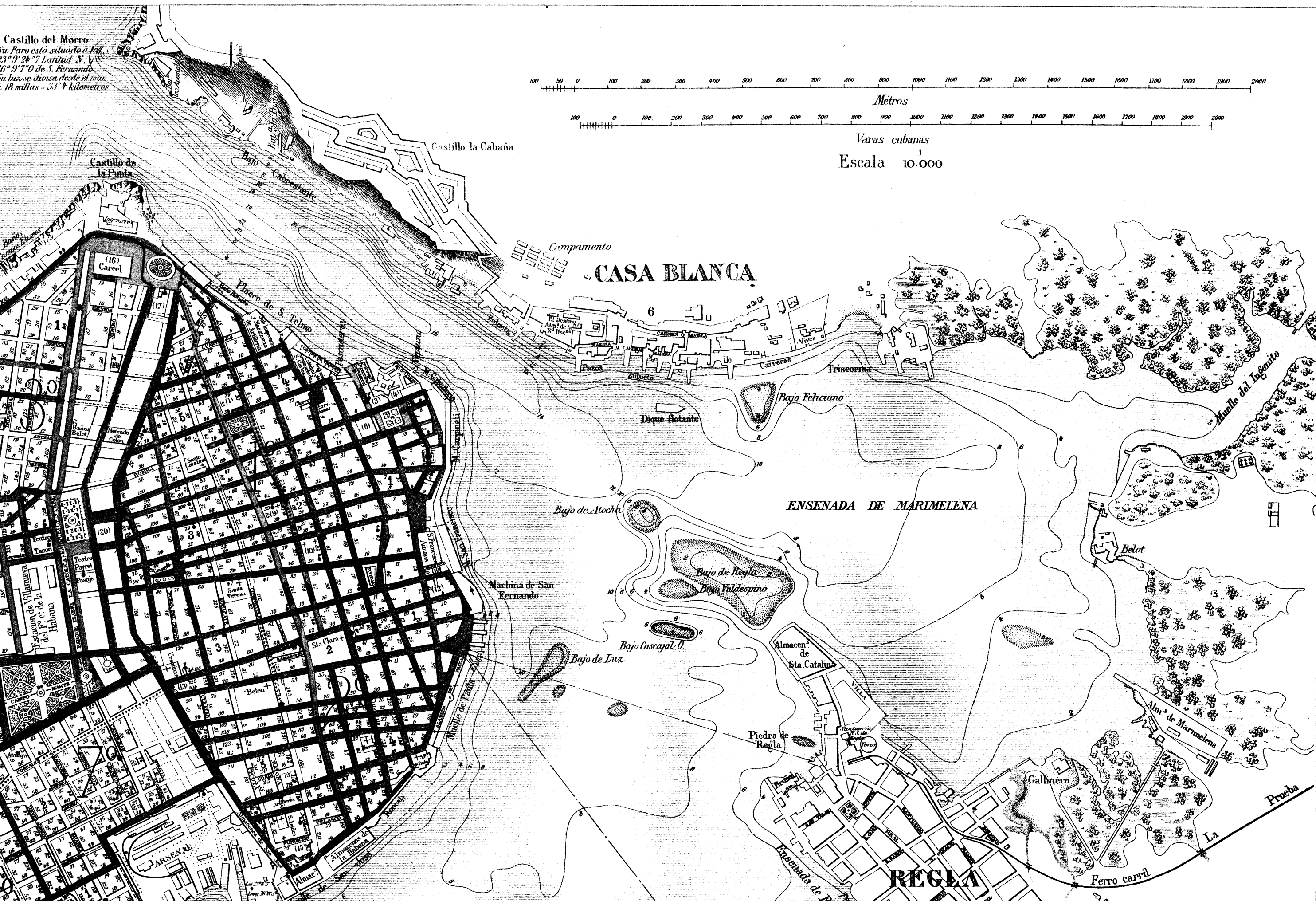
Castillo del Morro
Su Faro está situado a los
23° 9' 24" T Latitud N. y
76° 9' T O de S. Fernando
Su luz se divisa desde el mar
a 18 millas = 33 1/2 kilometros

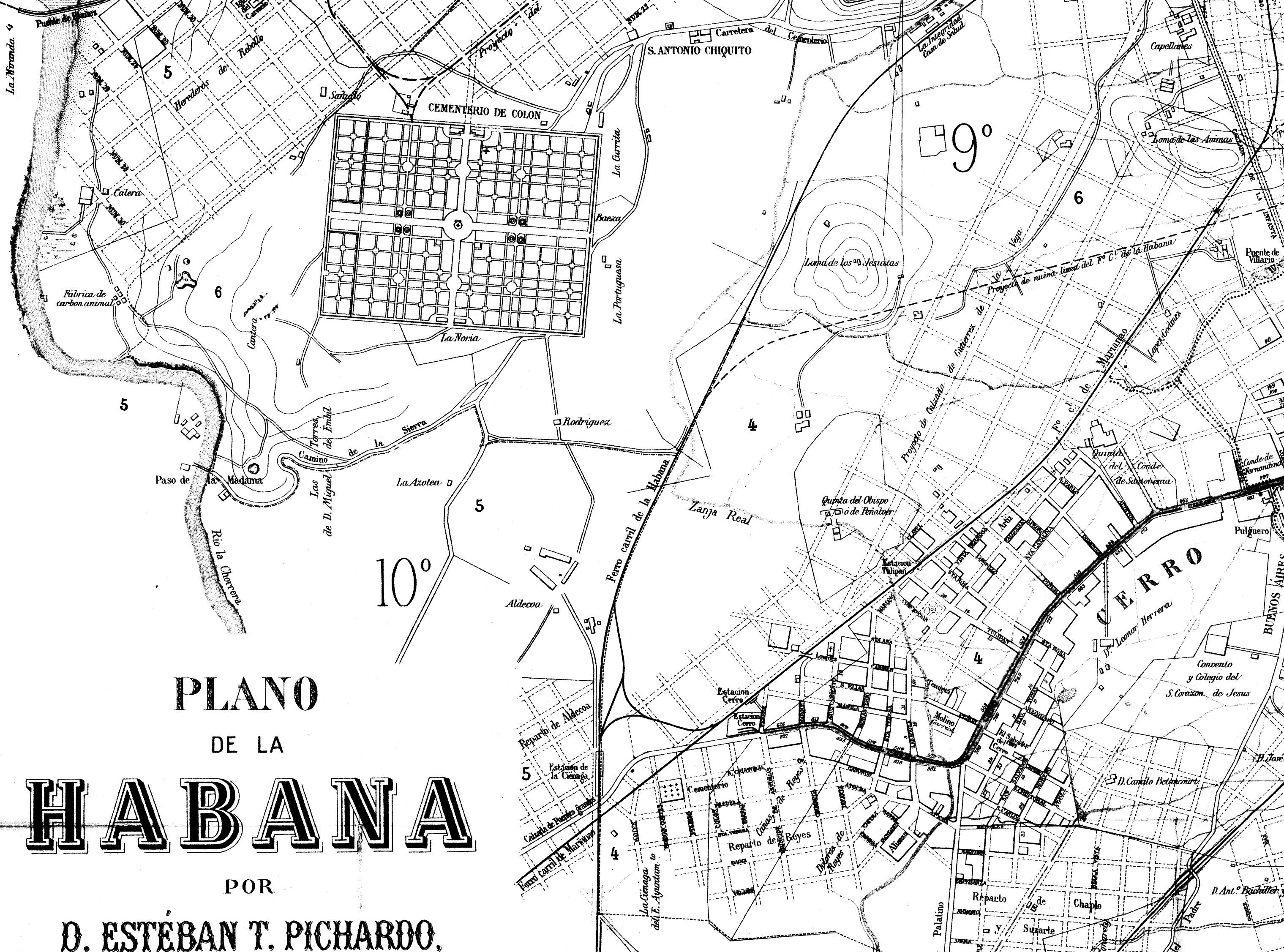


Castillo del Morro
Su Faro está situado a las
33° 9' 24" 7 Latitud N. y
66° 9' 7" 0 de S. Fernando
Su luz se divisa desde el mar
a 18 millas = 33 1/2 kilometros



Varas cubanas
Escala 10.000¹





PLANO
DE LA
HABANA

POR
D. ESTEBAN T. PICHARDO,





PLANO DE LA HABANA

POR
D. ESTEBAN T. PICHARDO,

AGRIMENSOR Y MAESTRO DE OBRAS.

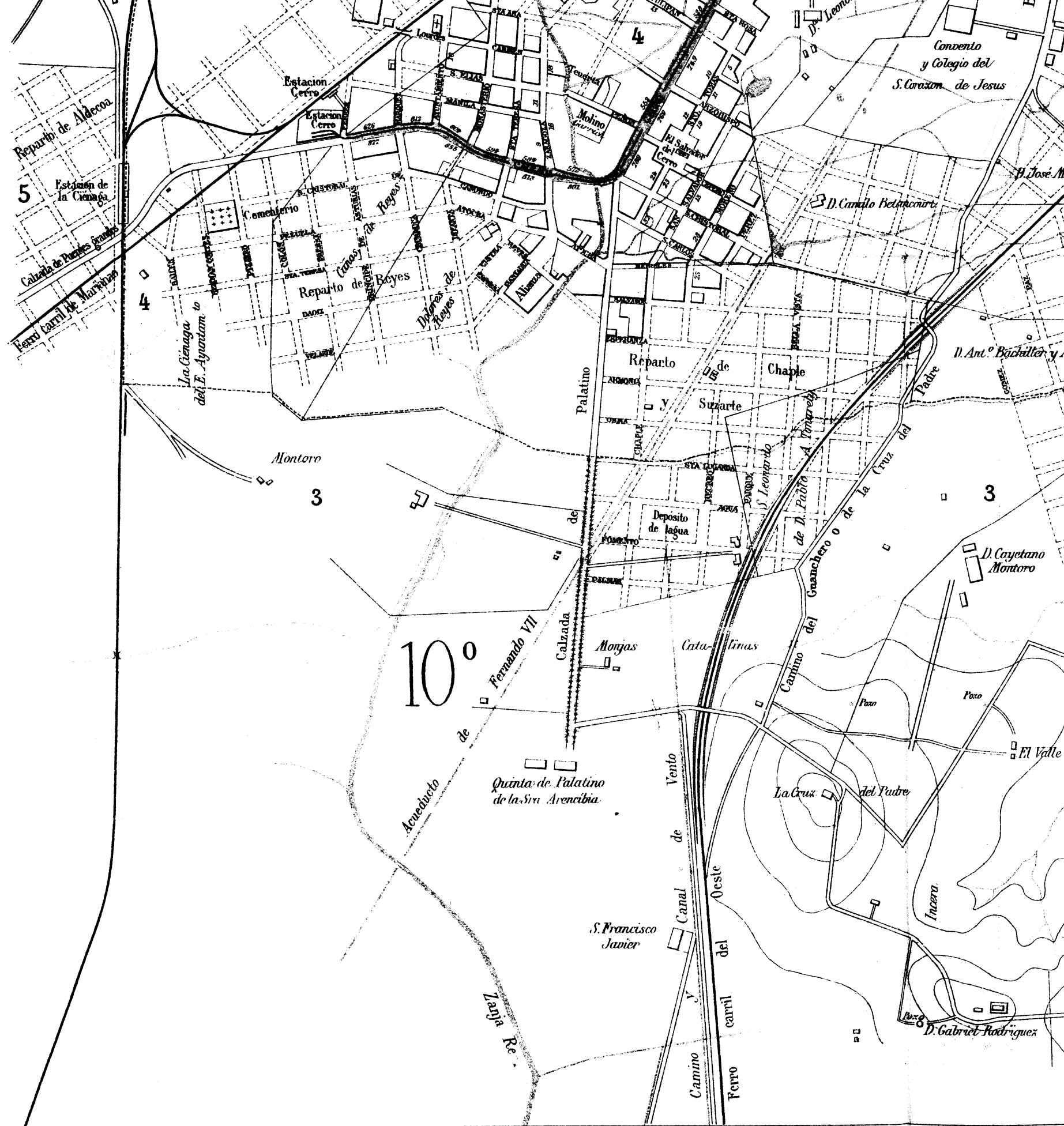
EDITOR: D. JOSÉ VALDEPARES.

Para la formación de este Plano, se han tenido presentes: el publicado por el Excmo. Ayuntamiento, el del Puerto por los Ingenieros de Obras públicas, y otros debidos a los Sres. D. Mariano Carles, D. Jose Ocampo, D. J. Manuel Alvaro, D. Alberto de Castro, D. Antonio Ariza, D. José Lopez Trigo, D. José C. del Castillo, D. Simon Teja &c; cuyos trabajos ha combinado el Autor del presente, añadiendo los que practicó expreso sobre el terreno.

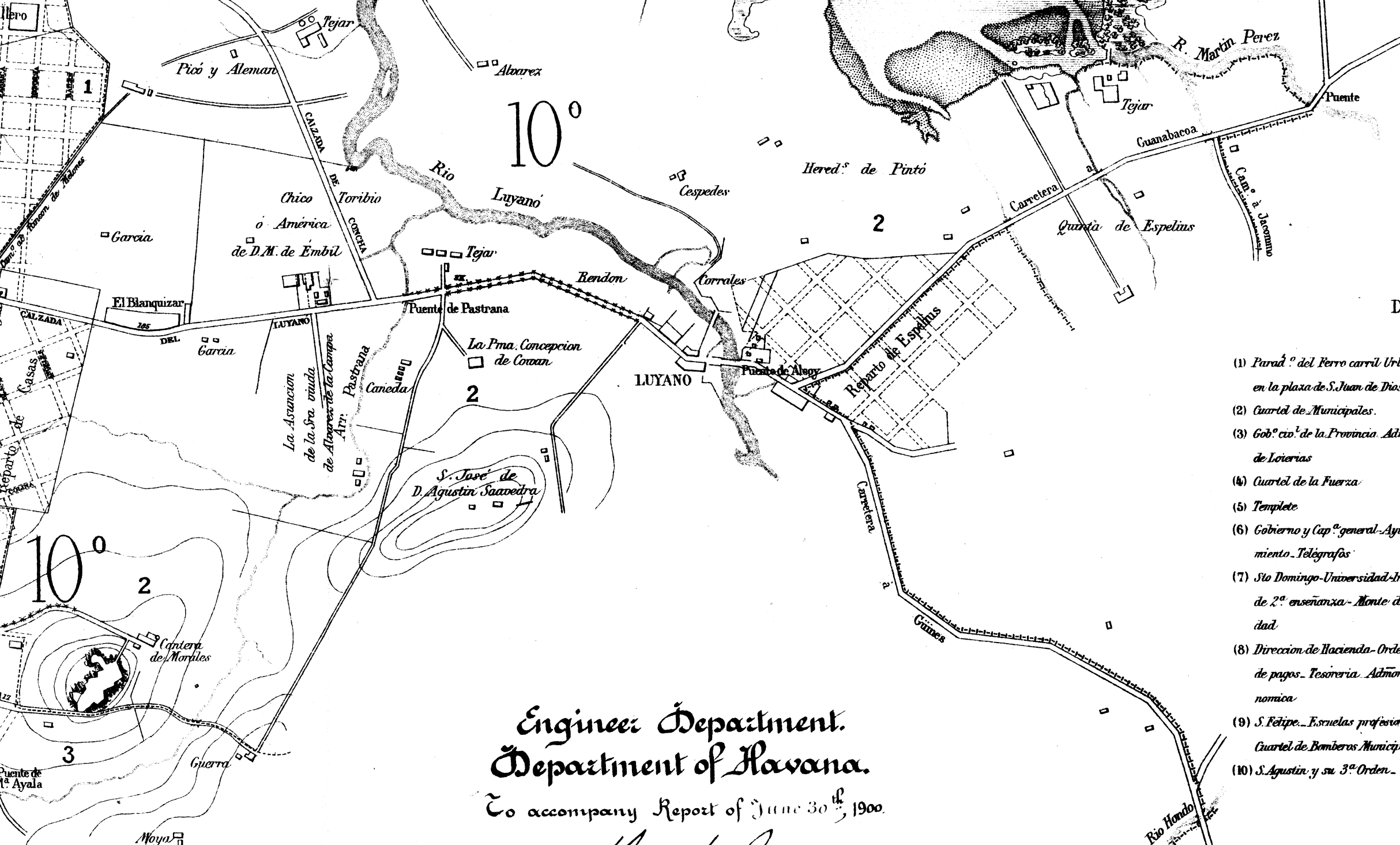
Las curvas de igual sonda, dibujadas en el Puerto, indican la profundidad del agua de dos en dos metros, en baja mar, y están deducidas del sondeo verificado por O. públicas en 1874.

- 5 Estac^{ta} telegráfica
- Caja de agua
- ◆ Caga y sifon
- Sifon
- Ferrocarril en explotación
- - - Idem en proyecto
- † Parroquia
- · - · - Límite Municipal
- · - · - Idem de Distrito municipal
- · - · - Idem de Barrio
- +++++ Idem de Parroquia

Los números de las casas corresponden al último de cada frente de manzana, y están escritos en carácter italico, como 1, 2, 3, &c.
Los que se refieren a la numeración del Directorio, están escritos en carácter romano, y entre paréntesis: (1) (2) (3) (4)
Los orinales de los Distritos municipales son de carácter capitales y tamaño grande: 1°
Los de los barrios son de carácter romano, mayores que los del Directorio: 1, 2, 3







DIRECTORIO

- | | |
|--------------------------------------------------------------------------|------------------------------------------------------------------------|
| (1) Parada del Ferrocarril Urbano, en la plaza de S. Juan de Dios | Academia de ciencias medicas, fisicas y naturales. |
| (2) Cuartel de Municipales. | (11) Admon. de Correos - Intervencion de Marina. Deposito hidrografico |
| (3) Gob. civ. de la Provincia. Adminis. de Leorias | (12) Comand. en jefe del Apostadero |
| (4) Cuartel de la Fuerza | (13) Cuartelillo Bomb. municipales |
| (5) Templo | (14) Cuartel Bomb. del Comercio |
| (6) Gobierno y Cap. general. Ayunta. miento. Telégrafos | (15) Casa de Recogidas, de S. Juan Nepomuceno |
| (7) Sto Domingo-Universidad-Instituto de 2.ª enseñanza - Monte de piedad | (16) Carcel. Presidio Hospital civil de S. Felipe y Santiago |
| (8) Direccion de Hacienda-Orden. de pagos. Tesoreria. Admon. Economica | (17) Morgue o Necrasamio Obras municipales |
| (9) S. Felipe. Escuelas profesionales. Cuartel de Bomberos Municipales | (18) Asilo de S. José, de Artes y Oficios |
| (10) S. Agustín y su 3.ª Orden. | (20) Teatro de Albizu, o de Llerandi |
| | Casino español |
| | (21) Cuartel de la Guardia civil |

Engineer Department. Department of Havana.

To accompany Report of June 30th, 1900.

W. M. Black

Major Corps of Engineers, U.S. Army.
Chief Engineer, Department of Havana.

Map showing Pavements Study Project.

Asphalt..... Red
New Granite Block..... Blue.

varying in diameter from 3 to 8 inches, to be placed, where used, alongside or beneath sewage conduits. Total length subsoil drains, 30,000 meters.

The minimum width of trench for sewers is prescribed. No maximum is given and the contractor would be entitled to receive pay for such quantity of material as he might think proper to remove.

The great depth of the proposed trenches—13 to 35 feet—involves an enormous quantity of excavating, which is classified under six heads, varying in price from \$1.90 to \$7.14 per cubic meter. The project does not specify who shall make the classification. The quality of materials, such as brick, cement, and vitrified clay pipe, is not specified.

The estimate provides for 24,000 meters of iron pipe for the force main, at a price of \$25.31 per lineal meter. Neither quality, dimension, nor weight is specified. The trench for this pipe is estimated at an average depth of two meters, amounting to 48,000 cubic meters of excavation, for which a charge is made of \$3 per cubic meter. A charge of \$29,670 is made for sheathing said trench. These items are all excessive and the sheathing largely superfluous.

The depth of the main sewers in the narrow streets presents a serious difficulty with respect to settlement of the house-drain connections.

The item for sheathing sewer trenches during construction amounts to \$485,609. The specifications would allow the contractor to increase or diminish this item at will.

An excessive price is provided for removal of surplus material.

No provision is made for right of way for 7 miles of force main. Specifications for pumping station and plant are deficient. The method of emptying sewage into the sea, although a serious problem, is not specified. Attention is invited to the unit price and deficiency in specifications, as shown in appendix.

Mr. Dady's estimate for sewer system is outlined as follows:

| | |
|-------------------------------|---------------------|
| | Spanish gold. |
| Estimated cost of sewers..... | \$5,949,848.65 |
| Subsoil drainage..... | 48,144.00 |
| Pumping plant..... | 1,373,490.99 |
| Rain-water sewers..... | 1,036,387.68 |
| | <hr/> |
| Paving..... | 8,407,871.32 |
| | 4,192,583.21 |
| Total..... | <hr/> 12,600,454.53 |

These amounts include an allowance of 18 per cent for "contingencies, engineering, and profit."

PAVEMENT.

Mr. Dady proposes three classes of pavement—sheet asphalt, 200,000 square meters; granite block, 300,000 square meters, and old granite blocks to be relaid upon asphalt concrete base, 245,000 meters. Except for portions of Calzadas del Cerro and Jesus del Monte, all of this pavement is to be laid on streets east of Belascoain. He proposes the use of Cuban asphalt, the value of which, as a paving material, has never been demonstrated. The specifications, therefore, are indefinite.

Granite block pavement is proposed for streets which could be adequately paved by a less noisy and cheaper material.

The distribution of the sheet asphalt and granite block pavement as given by him is shown upon the accompanying map.

The streets upon which the old granite blocks would be re-laid, are not specified, and under the proposition they might be laid at such places as the contractor would choose.

With the exception of a very small portion of large blocks, one foot square or more, the blocks in use upon the streets of Habana are valueless for re-laying. They are small in size and wedge shape, which prevents their being turned end for end: the used face is so rounded by wear that it is unsafe for animals.

A very slight provision is made for streets running north and south.

No pavement is specified for that district lying between Egido street, Calzada del Monte, and Matadero Creek, except for portions of three streets. This district includes the lowest portion of the town, has extremely heavy traffic, and needs an impervious pavement.

It is to be noted that his project proposes the construction of only 200,000 square meters of modern improved pavement, and that would be built of doubtful material.

His estimated cost per square meter for this sheet asphalt pavement is \$5 Spanish gold. The estimated cost of granite block pavement per square meter is \$6.17 Spanish gold. The proposed relaying of old granite blocks is estimated at \$2.93 per square meter, Spanish gold. The estimated cost of the proposed paving is \$4,192,583.21 Spanish gold.

PAYMENT.

Payment to be provided for by an issue of 6 per cent. fifty-year Spanish gold bonds, an issue of which to the full amount of the estimate would be placed, prior to the commencement of work, in the hands of designated depositaries, the Spanish Bank of the Island of Cuba, and the Mercantile Trust Company of New York, payments of the bonds to be guaranteed by special mortgage upon all city real estate.

Redemption of bonds is provided for, as well as the payment of the interest, by special tax, this tax to be collected by the bonded depositaries; the redemption of bonds and payment of interest also to be made by these depositaries. No limitation is placed (Economic Conditions, paragraph 6) upon the expenses which might be incurred by the bonded depositaries in the collection of taxes, or upon the charges for services to be rendered for redemption of bonds or payment of interest. The city of Habana, however, shall "pay the sums which these services may require."

In paragraph 7 the construction company agrees to accept the bonds of 10 per cent discount, deducting the cost and minimum expenses of their issue and flotation.

Paragraph 9 gives the construction company the right, at all times during the continuation of the contract, to exchange with the bonded depositaries money for bonds, and makes it the duty of the depositaries to accept such exchange.

The provision for monthly payments (paragraph 10) does not provide that the decision of the city engineer shall be final and conclusive; the contractor apparently has the right to receive payment in New York or Habana, as he might prefer.

Paragraph 11 is so drawn that the contractor might obtain practically unlimited extension of time (stated as five years) allowed him for completion of work.

Paragraph 12 provides for the execution of extra work which the contractor may do, in whatsoever manner ("most convenient manner") he might desire.

Paragraph 13 provides that the contractor shall remain in possession of the work throughout life of the bonds; that he shall operate the sewer system at the rate of \$90,000 per annum for that period. Payments for such operation, amounting to more than \$4,000,000, are provided for, and the paragraph is so drawn that were a simpler and less expensive method of disposal to be adopted, he might still receive the stipulated amount.

Paragraph 14 provides that the contractor shall receive annually for pavement maintenance, 10 cents per square meter, or \$74,581.40. This arrangement would also continue until the maturity of the bonds, and would insure to the contractor total receipt for such maintenance of more than \$3,300,000. No representative of the city is designated as the judge of the amount of repairs necessary or of the quality of repairs made. Throughout the proposed contract there is an entire lack of protection to the city with respect to inspection and acceptance of the work, as to sufficiency, quality, and satisfactory operation.

The preliminary design and estimate for a sewerage system for the city of Habana to cover the whole built-up portion of the city, including Jesus del Monte, Cerro, and Vedado, have been made under the direction of the chief engineer, by Mr. D. E. McComb, of Washington, D. C.

The prices used in the estimates were carefully considered and derived in large part from actual experience in this city.

It is certain that a complete system of sewerage for the city of Habana can be built within an expenditure of \$5,000,000. Such a system would provide for the sewerage of a population of 500,000, together with storm sewers of ample capacity to care for the drainage.

Such system would also make a covered sewer of Matadero Creek and the several branches of the Zanja Real, all of which at present are sources of danger to health.

Three million two hundred thousand dollars would give to the city 800,000 square meters of modern pavement, which would meet the needs of the present time, and cover more than the entire area specified by Dady.

An expenditure of \$8,250,000 would give to the city a complete system of sewerage and modern pavements, now needed. Mr. Dady's proposal, if carried into effect, would cost the city \$14,000,000 in Spanish gold, give an insufficient and badly chosen pavement, provide for sewerage only to the eastward of Belascoain street, provide insufficiently for storm water, lay upon the city an annual charge of \$165,000, Spanish gold, for maintenance of its sewerage and pavement systems, exclusive of interest on bonded debt.

Respectfully submitted.

P. D. CUNNINGHAM,
Acting Chief Engineer.

HABANA, December 2, 1899.

Appendix.

UNIT PRICES AND SPECIFICATIONS.

Prices.—Comparative schedule of prices of the Dady proposal and present corresponding prices. (Dady prices in Spanish gold; present prices in U. S. currency):

| Materials. | Dady price. | Present price. |
|-----------------------------------------------------------------------------------------|-------------|----------------|
| Concrete, in place | \$22.56 | \$10.00 |
| Bricks for conduits, per 1,000, at work | 33.81 | 22.00 |
| Building brick, per 1,000, at work | 57.66 | 30.00 |
| Bricks for manholes, flush tanks, mud deposits, vents, and traps, per 1,000, at work .. | 20.00 | 17.00 |
| Cast-iron valves, each, at work: | | |
| 3-inch | 19.12 | 7.80 |
| 3½-inch | 22.80 | 10.00 |
| 4-inch | 27.58 | 12.42 |
| 6-inch | 52.62 | 24.00 |
| 8-inch | 94.99 | 36.00 |
| 12-inch | 195.53 | 64.00 |

The Dady prices average about double present prices.

Excavation.

[Average cost per cubic meter; depth 0 to 16 meters.]

| | Loose earth. | | Loose rock. | | Solid rock. | |
|-----------------------|--------------|------|-------------|------|-------------|------|
| | Dry. | Wet. | Dry. | Wet. | Dry. | Wet. |
| Dady figures | 1.90 | 2.85 | 2.37 | 3.55 | 4.76 | 7.14 |
| Present figures | .75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.25 |

| | Vitrified clay pipe delivered on the work, all charges paid. | | | | Specials delivered at work, all charges prepaid. T and Y branches vitrified clay. | | | | Vitrified clay bends and curves, delivered at work, all charges paid. | | | |
|---------------|--------------------------------------------------------------|------------------|--------------------------|-----------------------------------|-----------------------------------------------------------------------------------|----------------|--------------------------|-----------------------------------|-----------------------------------------------------------------------|----------------|--------------------------|-----------------------------------|
| | Dady price. | Present cost. | Dady laying and calking. | Present price laying and calking. | Dady price. | Present price. | Dady laying and calking. | Present price laying and calking. | Dady price. | Present price. | Dady laying and calking. | Present price laying and calking. |
| | <i>Per foot.</i> | <i>Per foot.</i> | | | <i>Each.</i> | <i>Each.</i> | | | <i>Each.</i> | <i>Each.</i> | | |
| 6-inch | \$0.78 | \$0.18 | 0.17 | 0.04 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 8-inch | 1.15 | .28 | .19 | .05 | \$2.50 | \$0.88 | \$0.10 | \$0.03 | \$1.30 | \$0.67 | \$0.07 | \$0.02 |
| 10-inch | 1.65 | .39 | .20 | .11 | 3.54 | 1.45 | .35 | .09 | 2.08 | .86 | .09 | .03 |
| 12-inch | 2.46 | .50 | .36 | .14 | 4.75 | 1.98 | .41 | .11 | ..... | ..... | ..... | ..... |
| 15-inch | 3.14 | .74 | .45 | .18 | 6.74 | 2.75 | .48 | .14 | ..... | ..... | ..... | ..... |
| 18-inch | 4.22 | 1.02 | .58 | .23 | 11.99 | 3.82 | .60 | .19 | ..... | ..... | ..... | ..... |
| 22-inch | 5.81 | 1.37 | .65 | .29 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 24-inch | 7.82 | 1.81 | .72 | .32 | 17.00 | 7.10 | .69 | .21 | ..... | ..... | ..... | ..... |

SPECIFICATIONS.

Paragraph 3: The sizes of the cast-iron pipe not specified. Specifications regarding quality are poor.

Paragraph 6: Specifications regarding cement are incomplete in every respect.

Paragraph 8: Specifications for mortar specify but one kind of mortar, irrespective of the class of work. Specifications for concrete also very bad. Concrete as specified will be of poor character, which may answer in certain cases, but certainly not in others.

Paragraphs 11 and 12: Specifications for stone. Quarries are specified but not quality of stone, which experience has shown varies greatly in the same quarry.

Paragraph 13: Specifications for manholes. Very poor and indefinite. Manholes are not of the most approved pattern.

Paragraph 15: Calls for a particular flush tank, without specifying that those of equal value may be accepted.

Paragraph 18: The shoring of the ditches is specified in detail, which is important, as these details must vary with the nature of the soil, and specifications for this could be omitted entirely, the contractor being held responsible for any expense, which he would not be were he to follow out the specifications which had been approved.

Paragraph 19: Showing width of ditches, also unnecessary.

Paragraph 21: Permits the contractor to employ any kind of material required for the transportation of machinery and also permits him to use powder and dynamite without specifying the size of blast. This paragraph does not place the responsibility, as it should, for loss due to explosion.

The only paragraph limiting the amount of work that can be done is found in the last part of paragraph 24, in which the contractor can not open more than three-fourths of the street, and is obliged to take the necessary precautions to prevent accident; the excavations to be made in such a manner as to disturb to the least degree possible the neighbors and passers-by. All necessary precautions will be taken in order that the flow of water shall not be interrupted during the progress of the work. It will be noted that nothing is said about the use of parallel streets simultaneously by the contractor; nor have the city authorities any control over the location and amount of work to be prosecuted at one time, even when it is necessary.

Paragraph 26: Contractor required to carry earth removed from the ditches for a distance of 1 kilometer. Yet this material must be carried farther than 1 kilometer, and for this work the contractor must be paid extra, as stipulated elsewhere in the contract.

Paragraph 30: Is badly drawn and will apparently permit the contractor to make claims for work done for the protection of gas or water mains and pipes.

Paragraph 31: Provides for paying the contractor for extra work called for by the engineer. The paragraph is not clear as to who shall decide as to the amounts of labor and material employed by the contractor.

The paragraph referring to the pumping plant very insufficient.

Paragraph 65: Specifications for cement entirely inadequate. Specifications for sand do not specify whether it shall be silicious or calcareous.

Paragraphs 67 and 68: Not clear in regard to the faces of the paving blocks being planed and would apparently permit the use of blocks the faces of which are rough, so that these blocks could not be reversed when worn on top.

Paragraph 69: Brick is permitted to be used with broken stone in the concrete.

Asphalt pavements to be made of Cuban asphalt. The specifications decidedly indefinite. This is a very important specification, inasmuch as the Cuban asphalt has been but little used, and, so far as is known, has not stood the test of time. The fact that it is very little used will go to show that there are objections to its use which even the intense rivalry existing between the asphalt companies in the United States has not been able to overcome.

Paragraphs 71 and 72: Provide for extra payment in case of excavations for pavement beyond a depth of 12 inches, but do not state who shall decide upon the necessity for such excavation or fix the amount the contractor shall be paid.

Paragraph 73: Specifications for concrete vague and permit the use of brick.

Paragraph 74: Specifications for binding coat of bituminous cement are also vague. The stone provided for is entirely too large.

Paragraph 75: Providing for paving with granite blocks between tram rails is not in conformity with good practice. In addition, under their concessions the street railway companies are compelled to pave between the tracks and on both sides of them. The specifications call for a 5-ton roller, which is entirely too light.

Paragraph 78 provides for concrete of 1 part Portland cement, 3 parts clean sand, 7 parts broken stone, which would be too porous.

Paragraphs relating to the asphaltic cementing of the joints are also faulty.

In no part of the specifications is there any provision giving the city authorities the right to judge as to the sufficiency of the material or the adequacy of the work done.

The contractor, although not given full power to determine for himself, at least under these specifications, would have a case which he could bring before the courts on the ground that no one is specified whose decision as to disputed points shall be final.

There are no means of computing what may be involved in the provisions for extra work, which is mainly left to the discretion of the contractor, and may amount to a very large sum in addition to the estimate.

The engineering features were later carefully examined by Mr. Gray, and the following additional report was submitted:

HABANA, CUBA, *January 10, 1900.*

SIR: Replying to your request for a brief memorandum regarding the engineering and financial provisions of the "Dady contract," so called, I have the honor to submit the following:

The plans and specifications state that the work proposed to be done is divided into five parts, namely: First, the removal of sewage from domiciles and factories; second, the disposal of sewage in such a way as will not injure the health or offend the sight and smell; third, the drainage of subsoil; fourth, the removal of storm water from public highways; fifth, the paving of streets and walks with modern and sanitary pavement.

The first and fourth parts, which refer to the removal of sewage from domiciles and factories and of storm water from public highways, are so closely identified with each other that they may be considered as one part, and they are so treated herein.

CONTRACT AND SPECIFICATIONS AS A WHOLE.

Among the objectionable points and defects which apply to the whole contract, covering all parts of the work, may be mentioned: First, the obscurity or absence of any stated authority representing the city, who shall direct and control the work, and who shall be judge as to the fitness of the materials to be used or the quality of the work performed. On page 13 of the specifications, where the engineer is referred to as the person who is to take the estimates, and on page 32, where it states that "if the subsoil is soft and spongy—then the contractor will do as the engineer directs" and "materials used and work done will be paid for at the price signified in the contract." Second, the lack of proper, definite specifications of quality of material to be furnished, and the manner in which the details of the work shall be done. Third, the excessively high price to be paid for each and every item of material and work included in the contract, as well as for unknown contingencies, being in almost if not in every case (excepting for paving) at least twice what would be a fair and profitable price. Fourth, the lack of any proper bond or guaranty holding the contractor responsible for damage done to abutting property, or obliging him to fulfill the terms of his contract. Fifth, the issuing, previous to beginning the work, of the total amount of bonds necessary to complete the whole work, which will cover several years' time for its construction, thereby entailing a large unnecessary interest account, before portions of the money are needed.

SEWERAGE AND REMOVAL OF STORM WATER.

The sewage, after being collected at a central point, is to be lifted by pumps and discharged into tide water on the northern coast of the island, about 5 miles north-east of the city. The storm drains are to discharge by gravity into tide water.

A few brief statements of facts will show to what degree the sewerage system, if built as proposed, will accomplish the result claimed for it, or serve the needs of the city.

Among the defects in the specifications relating to sewers and storm drains (not already enumerated as applying to all parts of the work) may be mentioned: First, the insufficient size of the sewers and storm drains to carry the amount of water which will come into them, or for which they should be designed; second, the excessive depth at which most of the sewers are to be laid; third, the rate of grade in many cases being insufficient to produce the necessary velocity to prevent deposits from accumulating in the sewers; fourth, important areas of the city not provided with sewers; fifth, failure to specify quality of materials or class of work; sixth, the unnecessary amount of sheeting to be used, thereby adding useless expense to the construction; seventh, badly designed work; eighth, the high price to be paid for the work, the exorbitant sum of money to be given the contractor annually for maintaining the sewerage system, and absence of any statement as to what will constitute a maintenance.

CAPACITY OF THE SEWERS AND STORM DRAINS.

The specification for sewage states that the proposed sewerage system is to take the domestic sewage "and rain water from roofs and yards, and a part of the rain from the streets." And it also states that the rain water will be removed from the streets

by means of storm drains. Furthermore, the specifications state that the capacity of the sewers is based upon a daily consumption of 100 liters, or 26 4-10 gallons per capita per day. Comparing this with the present consumption of 173 United States gallons per capita per day, which experience in nearly all large cities in the United States has shown can not probably be reduced to much less than 100 gallons per capita, shows how inadequate the system will be for removing domestic sewage, especially as the sewers are also to receive rain water from roofs of buildings, from courtyards and streets, as is stated in the specifications.

The specifications also state that the storm drains are designed to carry one-half a cubic meter per hectare per hour, or about 2-1,000 of inch in depth.

Bearing in mind that we have records in Habana of at least one storm when it rained at the rate of 3 inches per hour, and several when it rained at the rate of 2 inches per hour, and that rain storms occur almost annually, and in some years several times during the year, at a rate upwards of $1\frac{1}{2}$ inches per hour; and assuming that at times two-thirds of the storm water will reach the sewer within the hour (which is a reasonable assumption), we shall have the respective rates of 2 inches, $1\frac{1}{2}$ inches, and 1 inch of rain water reaching the sewers within the hour, or 1,000 times as much as is provided for in the storm drains of the Dady plans, when raining at the rate of 3 inches per hour, and 666 times as much when raining at the rate of 2 inches per hour, and 500 times as much when raining at the rate of $1\frac{1}{2}$ inches per hour. Therefore, as the sewers and storm drains as specified will carry only a small portion of the storm water, and as the present sewers which are to be removed carry a larger quantity than is specified for the Dady project, the result will be that the surplus water will flood the streets even more than at the present time.

With this condition of affairs, the sewers will at times be overcharged with sewage and storm water, resulting in overflowing courtyards or patios, depositing on their surfaces more or less sewage, causing much annoyance, and possibly be the means of spreading disease.

The plan proposed is decidedly inadequate for present needs. It makes little or no provision for growing portions of the city, and besides leaves out a large part already thickly populated, hereinafter mentioned.

DEPTH OF SEWERS.

The sewers are to be laid at a depth of from 5 to about 50 feet from the surface of the ground, the greater part of them being excessively and unnecessarily deep, thus entailing needless expense in the first cost, and compelling the abutters connecting with them to be at a great expense for repairing their connections should they ever require it.

Furthermore, in case of stoppage to the sewers it will be much more expensive to clear them than would be the case if laid at a less depth; and in case of repairs being needed the extra cost of such deep excavation, the obstruction to public travel, and the depriving property owners of the use of the streets, will constitute no small item.

GRADES OR INCLINATIONS OF SEWERS.

The specifications state that the grades or slopes "adopted for sewers" are such as will produce 40.25 meters per minute (or 2.2 feet per second.) This velocity is too small to prevent deposits from accumulating in the sewers.

Of 171 profiles, a part or all of 60 sewers represented on them have not sufficient grade to produce a velocity of 3 feet per second, which is necessary to keep them clean. The storm-water drains in some cases, as designed, have grades that will give less than one-half a foot velocity per second.

In many cases the grades given on the profiles disagree materially from those given on the plan; and in many instances also the grades as drawn on the profiles are different from figures given on the same profiles.

AREAS NOT PROVIDED FOR.

The specifications state that the system is designed for 300,000 people, which is somewhat misleading, as it makes no provision whatever for sewerage for the portions of the city west of Belascoain or south of Matadero Creek, thus omitting the suburbs of Jesus del Monte, Cerro, Casa Blanca, and El Vedado, and the populous districts bounded by Calzada de Jesus del Monte and Matadero Creek, and the district bounded by Infanta street, Belascoain avenue, the Gulf of Mexico, and the Matadero Creek (about one-half of which latter area is well populated), in all containing at present upwards of 50,000 people. These portions which are omitted comprise almost all of the areas not now populated to nearly their maximum capa-

city, but which must necessarily be occupied if the city is to continue increasing in population.

The plan proposed contemplates sewerage only about 1,000 acres, leaving unprovided for about 6,800 acres. Neither does the plan provide for covering or otherwise caring for the Matadero Creek, which should not be left open, even were the present sources of its contamination entirely removed.

QUALITY OF MATERIALS AND CLASS OF WORK.

There is a marked absence of an adequate description or specification of the materials to be used in the construction of the sewerage system or storm-water drains.

It is true that the expressions "best quality" and "best class" are used several times in connection with the materials to be furnished; but these expressions are at best but glittering generalities as applied to the case in hand. The materials may be the best class that some works produce, and still be wholly unfit for sewerage purposes.

No mention is made of the depth of socket, or of the annular space between the pipe and the socket to receive the cement, and there is nothing in the description of the bricks to prohibit the use of a porous quality, or those containing lime, which, when water comes in contact with them, will cause the lime to slack and the bricks to disintegrate. On these, as well as many other important points, the specifications are silent. Mention, however, is made that the pipes and bricks shall be the same as samples accompanying drawings, which samples are not now to be found.

The specification (if such it may be called) for the cement states that experiments will be made with it before using; but it fails to state what these experiments will be, who shall make them, or what results are to be looked for.

According to the description as given for sand, a material can be used wholly unsuitable for the purpose and yet not be contrary to the specifications, owing to the meagerness and indefiniteness with which this material is specified.

The specifications are, however, explicit as to the methods of making monthly estimates for payments. The engineer is to make a monthly estimate of the value of materials delivered and work executed, "by multiplying the number of materials delivered and kinds of work done, by prices fixed in the table." The engineer is thus relieved of all responsibility as to the quality of material or class of work performed.

The concrete as specified is to be composed of 1 part of hydraulic cement, 3 parts sand and 7 parts stone. These proportions would make a weak and porous concrete, containing much less cement than it should to obtain good results, while the price to be received for it is twice what it ought to be for the best quality of American cement concrete.

The specifications are also deficient as to the method of laying the sewers. The accompanying drawing, which is a copy of a portion of the plans, may be intended to supply anything lacking in the specifications on this point. If, however, it possesses merit as a graphic representation of the method of doing the work, it does not do credit to a modern specification for the sewerage of the city of Habana.

SHEETING.

From the plans and specifications, together with the table of qualities, it would appear that it is proposed to use sheeting and bracing for the entire length of sewers. It will not be necessary to so extensively sheet the trenches, and therefore more or less money will be needlessly expended if sheeting is used to this extent. The trenches are also to be excavated of an unnecessary width, as is shown by the accompanying sketch, thus adding useless expense to the cost of the works.

DESIGN OF WORKS.

The works in several respects are poorly designed, notably in regard to the manholes.

OPERATION AND MAINTENANCE OF WORKS.

A complete sewerage system can doubtless be built, which will meet the needs of all the present populated districts, including marginal and intercepting sewers for the entire city, for less than one-half of what the Dady project will cost Habana.

The contractor is to have possession of and is to operate the sewerage works until the maturity of the bonds, for which service he is to receive \$90,000 Spanish gold annually, payable tri-monthly. The contract fails to specify with any proper defi-

niteness what the maintenance of the works shall consist of. The amount to be paid is an exorbitant sum for maintaining the sewerage system, being double what it need cost, at least for many years to come.

DISPOSAL OF SEWAGE.

The place where it is proposed to discharge the sewage is farther from the city than is necessary to take it at present. Other than this there would seem to be no objection to the general location for its final disposal. No plan or description is given indicating how far from the shore, or in what manner the sewage shall be discharged into tide water.

The information in regard to the outfall sewer is also very meager, as the proposal simply states that there will be two 24-inch iron pipes, each 12,000 meters long. These two pipes would not be of sufficient capacity to carry the present amount of sewage, excluding the rain water, which the specifications state the sewers are to receive.

No location is given of the outfall sewer, nor does it appear in the specifications that any right of way is provided for it. In the absence of any description of its location, it is impossible to say whether the line of outfall is the best that can be selected, or to what height the sewage must be lifted to get to the point of discharge.

As for the pumping plant, while parts of it are specified in detail, other important points are omitted altogether. Nearly two pages are devoted to describing the tools which are to be furnished with the engine, such as hammers, dies, pipe wrenches, etc.; while the duty to be performed by the engines is not referred to. They may be high-duty economical engines regarding the use of coal, or they may be extravagant and wasteful.

SUBSOIL DRAINAGE.

With the conditions which exist in Habana I believe draining the subsoil to be unnecessary, and consider unwarrantable the expenditure of \$40,800, which is the amount to be paid for this part of the work.

PAVING OF STREETS.

Defects in specifications for paving.—First, looseness of specifications, failure to describe quality of material and work, contradictions, and lack of clearness of meaning; second, noisy pavement to be laid where noiseless pavement should be placed; third, materials proposed to be used which are as yet untried, and therefore should not be adopted on a large scale; fourth, the assignment of the different classes of pavement to the various streets as stated in Mr. Dady's proposals is not believed to be in accord with the present needs of the city, and fifth, excessive price to be paid for the pavement, and for its maintenance.

Looseness of specifications.—The same general and even greater looseness of specifications prevail regarding the paving of the streets as regards the other parts of the works included in the contract, and besides are very obscure as to their meaning. In fact the specifications are so indefinite in general and so contradictory where they are specific, so contrary to general practice, and so wanting in clearness of expression that it is quite impossible to say what their meaning is, or how the work would have to be done to conform to them; as in one place they specify that the granite block paving is to be laid on a foundation of asphaltic concrete 6 inches thick, and in another place that the "granite paving stones" will be placed on a base called "inferior coat," which will be one-half inch thick. They furthermore mention a foundation which shall be made of hydraulic cement concrete 6 inches thick, and they immediately go on to say "after placing the paving stones as described," etc., directly implying (although not definitely stating it) that the stones are to be placed on this hydraulic concrete base, thus practically specifying no less than three distinct foundations on which the same "granite blocks" are to be laid. As has been stated, it is impossible to conceive what some parts of the specifications mean.

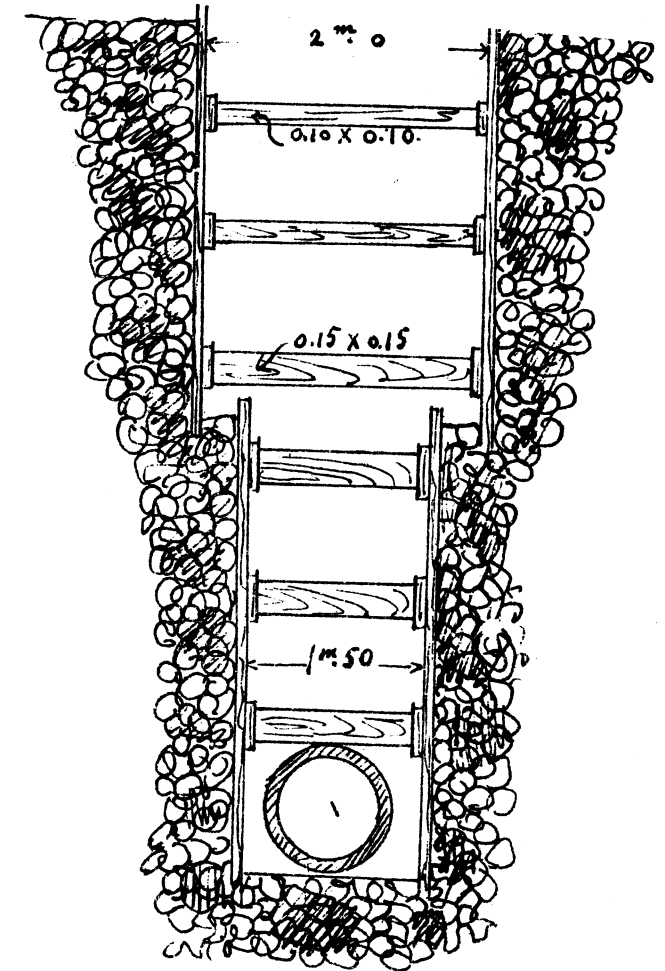
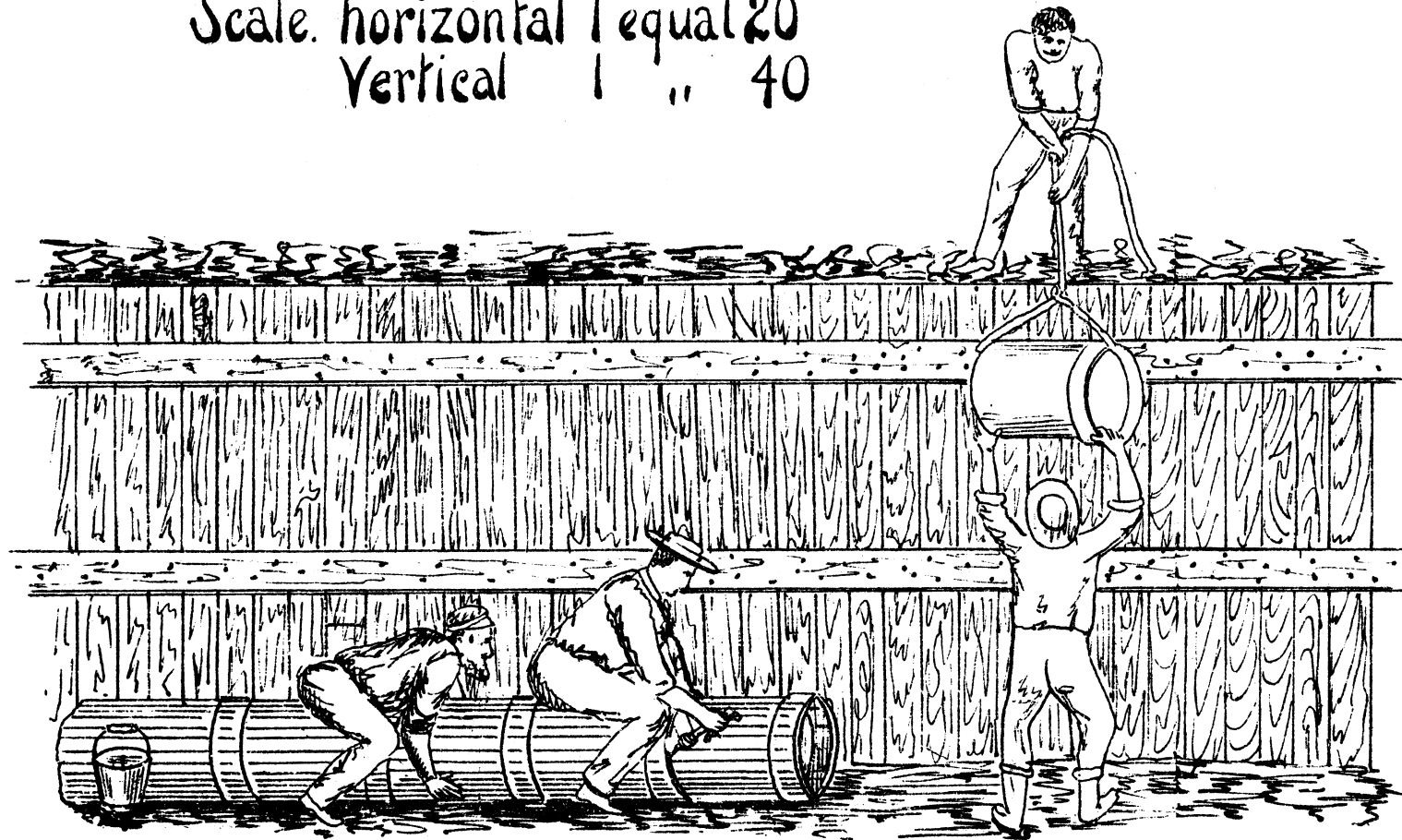
As an illustration of the looseness of the specifications, they specify the quality of cement to be used, as follows:

"The cement used for the construction of pavements, will be recently ground, either American or European, and will be stored in a dry place. Before using it, the necessary trials will be made." Nothing is said as to what the trials shall be, or what results will be required.

Questions of importance are left presumably to the discretion of the contractor, as there is no other authority designated; such questions as the nature of subfoundation, suitability of old granite blocks to be relaid, etc.

Office of Chief Engineer of Havana
DETAILS, From Drawing No 16 of the plans-
Havana Sewer System- M.J.DADY & CO.

Scale. horizontal 1 equal 20
 Vertical 1 " 40



JULIUS BIEN & CO PHOTO. LITH

Office of Chief Engineer
 Division of Cuba
 To accompany report of June 30th 1900
M. J. Dady
 Major Corps of Engineers U. S. Army.
 Chief Engineer, Division of Cuba.

Regarding the disagreement between the plans and the specifications, it may be stated that among the streets called for in the plan to be paved with asphalt, 8 of these are not mentioned in the list given in the specifications, and that of the streets as shown in the plan to be paved with old granite 72 are omitted from the list in the specifications, and of the streets shown on the plan to be paved with new granite 1 is omitted in the specifications. There are also 2 streets given in the list which are not represented in the plan to be paved. It would be supposed that the list given in the proposal would agree with streets represented in the plan.

Few, if any, of the present small blocks which compose a large part of the present street pavement are suitable for relaying, being very irregular in shape and not of sufficient depth. Most of them are fit only to be crushed and used in building macadam streets or used in making concrete. A small portion of the present pavement is composed of larger blocks, a foot or more square, and such of these blocks as can be split into proper shape may be used for repaving.

Noisy pavement where noiseless pavement should be laid.—Noiseless pavement should be used for the city of Habana wherever practicable. The narrowness of most of its streets, and the fact that in nearly all cases the abutting buildings, both public and private, are placed on the line of the streets, and that at all seasons of the year the doors and windows are kept wide open, are conditions which render a comparatively noiseless pavement in Habana an absolute necessity. Surely no city in the United States can be compared for noise with a narrow Habana street paved with granite blocks. Among the many locations where noiseless pavements are needed may be mentioned the post-office, custom-house, Maestranza Building, Habana University, opposite banks, schools, offices, and business houses, not to mention dwellings which are interspersed in almost every part of every street. Many requests are being received from abutting proprietors and owners of property asking for a noiseless pavement, and these show the local appreciation of such pavements. Certain of the citizens have already had such pavements put down in front of their own premises at their own expense.

The specifications call for 745,814 square meters (or 891,994 square yards) of pavement. Of this amount 201,400 square meters (or 240,874 square yards) are to be asphalt, while 544,414 square meters (or 651,119 square yards) are to be of granite, which shows what a small proportion of the proposed new pavement will be noiseless.

Materials proposed to be used which are as yet untried.—It is proposed to use Cuban asphalt for the asphalt pavement. So little is known of the wearing quality of this asphalt or its suitability for paving that it would not be prudent to adopt it without first giving it a trial by actual use. No description of its chemical or physical constituents will give any reliable basis by which to judge of its practicable value as a pavement. The fact that it has not come into use to any extent would seem sufficient reason for requiring some tangible practical result to be shown before using it on any greater than an experimental scale.

To use it for paving the streets of Habana untried, as it is at present, might prove a most deplorable blunder.

Lack of provision for paving a part of the city.—No provision is made for paving any of the city west of Belascoain, excepting Calzada del Cerro from Cuatro Caminos to the street railway station and Calzada de Jesus del Monte from the corner of Infanta and Calzada del Cerro to the corner of Luz, notwithstanding there are streets in this territory which require pavements.

Prices to be paid.—The price to be paid for the three different pavements—namely, the asphalt, \$5 per square meter; granite block (new block), \$6.17 per square meter, and for laying old granite blocks, \$2.93 per square meter—are in each case in excess of what would be a fair price. In addition to this the specifications state that the "construction company" will have charge of the streets to keep them in repair during the maturity of the bonds, and that "for these services the Habana city council will pay the construction company annually 10 cents per square meter, or \$74,581.40 Spanish gold trimonthly, payments in equal amounts." This is also an exorbitant sum to pay for these services, especially when considering the large first cost of the pavement and the quality of work that should be furnished for it. If, however, the work should be done in the same loose manner in which the specifications are drawn, perhaps \$74,581.40 per annum might not be sufficient to keep the streets in proper condition. It is certain that for prices less than those quoted above reliable companies will lay first-class pavements of the various kinds and guarantee their maintenance for a series of years.

Furthermore, the question might arise whether the sum to be paid for maintenance is to be at the rate of 10 cents per square meter or whether it is to be a lump sum of \$74,581.40, or whether it is to be optional with either party as to which it shall be. But as the specifications state that the area to be paved comprises 745,814 square

meters, it is presumable that it is the intention of the contract to pay at the rate of 10 cents persquare meter. An approximate estimate, however, of the number of square meters of paving to be laid, to conform to the streets shown in the plan and included in the list, makes 912,000 square meters; therefore, at 10 cents per square meter, it might cost the city upward of \$90,000 per annum for the maintenance of the street pavements. Nothing is stated in the Dady proposal as to the city officer who shall have authority to order repairs.

It may be well to mention that the bonds of the city of Habana would sell to-day at par, thus netting 10 per cent more to the city than the Dady contract allows for them.

It is not intended in this brief memorandum to make a full synopsis of the Dady contract, but only to point out some of the general defects. Many more points might be cited in which the specifications are faulty.

In conclusion, I have to say that no experiments of magnitude should be made in paving the streets of Habana. Furthermore, an impervious and comparatively noiseless pavement should be used as far as possible, especially for the business portions of the city. It is unnecessary to suggest that before laying down permanent and expensive pavements, as far as possible underground works, such as sewers and connections, should be built, renewals of water and gas pipes made where needed, and all other similar underground structures should be put in thorough condition in order that the pavement need not be disturbed when once laid.

Respectfully submitted.

SAMUEL M. GRAY,
Consulting Engineer.

Brig. Gen. WILLIAM LUDLOW,
Commanding General, Department of Habana.

Report of Mr. Samuel M. Gray, upon sewerage and drainage system for the city of Habana.

PROVIDENCE, R. I., June 5, 1900.

SIR: Having been requested by Brigadier-General Ludlow, U. S. A., late of the Department of Habana, Cuba, and by Col. William H. Black, of the U. S. Engineer Corps, to examine the city of Habana, and to devise a method for the sewerage and drainage of the city, I respectfully submit the following report:

INTRODUCTION.

In accordance with the above request, I visited the city of Habana in December last, and was then informed that you desired a careful study made of the conditions of Habana, with reference to the best method of sewerage and draining the city, and of the most practicable and thorough method of disposing of the sewage, leaving the minor details of the system to be worked out later, should it be decided to build the works.

Careful and detailed examinations were made of the city and surroundings, the harbor and the north shore of the island from Almendares River to Cojimar River, with the view of considering the best location for sewage disposal. Special study was also given to various locations in the city where storm water gives trouble, or is likely to in the future.

TOPOGRAPHICAL AND GEOLOGICAL CONDITIONS.

The city of Habana is located on the north shore of the island of Cuba at the entrance to Habana Harbor. The old part of the city covers an area of about 1,490 acres, situated between the harbor on the east and Calzada de la Infanta on the west. This section of the city is thickly populated, especially in the eastern and southern portions. The streets are generally narrow and closely built up, the buildings covering all the area bounded by the streets, with the exception of the small patios or courtyards.

The suburban districts cover approximately 3,750 acres, and are divided about as follows: Jesus del Monte and Cerro, 2,435 acres, and El Vedado and El Carmelo 1,315 acres, making, with the old section above mentioned, a total of 5,240 acres, or little more than 8 square miles of territory. This area does not include Casa Blanca or Regla, which suburbs together contain about 325 acres.

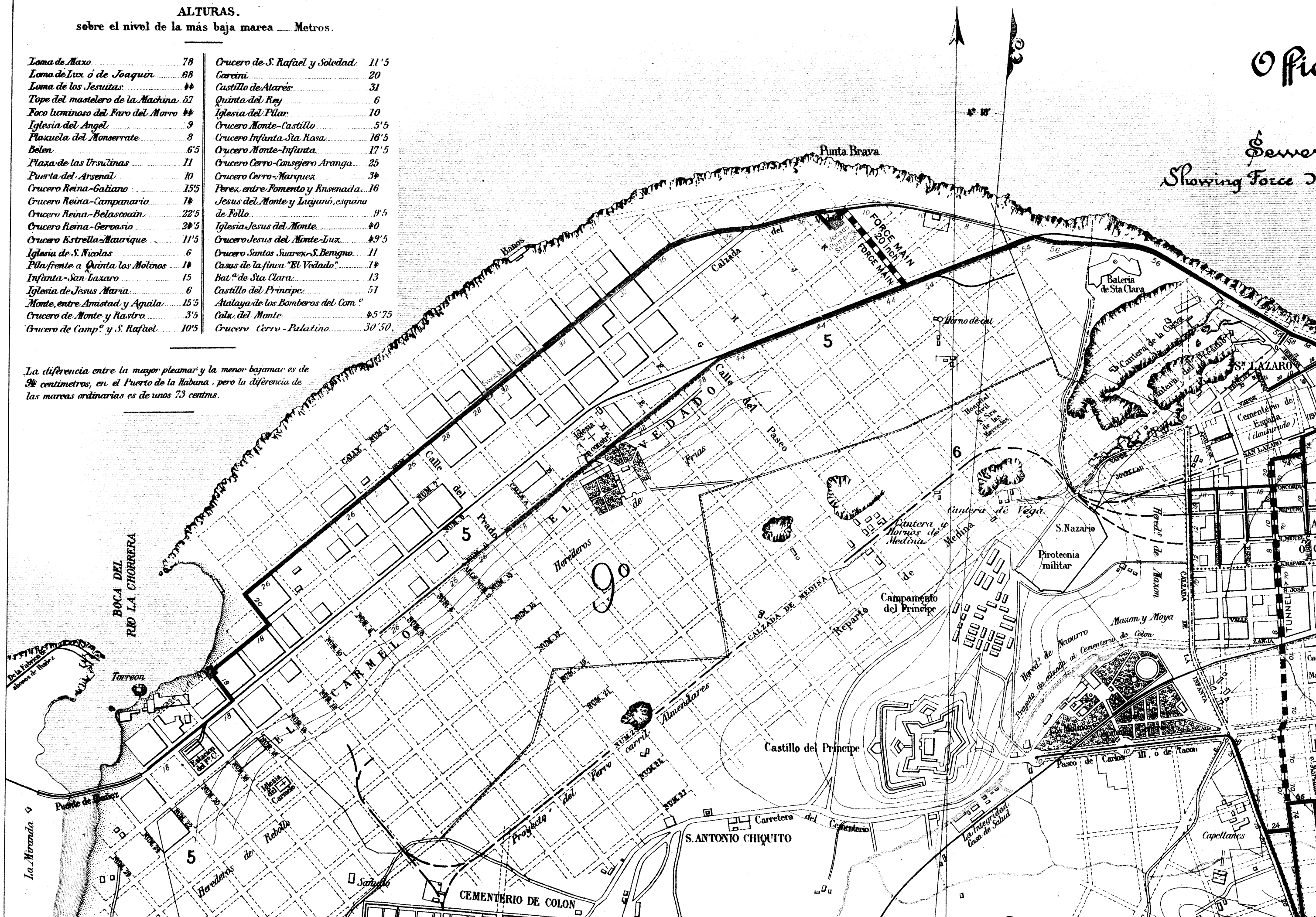
A large portion of the suburban districts is still open and unimproved. There are, however, localities in Jesus del Monte and Cerro that are thickly populated.

More than half the total area of the city naturally drains into Habana Harbor, the remaining area draining into the Gulf of Mexico on the north and Almendares River on the west.

ALTURAS.
sobre el nivel de la más baja marea — Metros.

| | | | |
|----------------------------------|------|-------------------------------------------|-------|
| Loma de Maxo | 78 | Crucero de S. Rafael y Soledad | 11'5 |
| Loma de Lux ó de Joaquín | 68 | Carciní | 20 |
| Loma de los Jesuitas | 44 | Castillo de Alarés | 31 |
| Tope del mastelero de la Machina | 57 | Quinta del Rey | 6 |
| Foco luminoso del Faro del Morro | 44 | Iglesia del Pilar | 10 |
| Iglesia del Angel | 9 | Crucero Monte-Castillo | 5'5 |
| Plazuela del Monserrate | 8 | Crucero Infanta Sta Rosa | 16'5 |
| Belén | 6'5 | Crucero Monte-Infanta | 17'5 |
| Plaza de las Ursulinas | 11 | Crucero Cerro-Comsejero Arango | 25 |
| Puerta del Arsenal | 10 | Crucero Cerro-Marquez | 34 |
| Crucero Reina-Galiano | 15'5 | Perez entre Fomento y Ensenada | 16 |
| Crucero Reina-Campanario | 14 | Jesus del Monte y Luján, esquina de Follo | 9'5 |
| Crucero Reina-Belascosain | 22'5 | Iglesia Jesus del Monte | 40 |
| Crucero Reina-Gervasio | 24'5 | Crucero Jesus del Monte-Lux | 49'5 |
| Crucero Estrella-Maurique | 11'5 | Crucero Santos Suarez-S. Benigno | 11 |
| Iglesia de S. Nicolas | 6 | Casas de la finca "El Vedado" | 14 |
| Pila frente a Quinta los Molinos | 14 | Bat.ª de Sta Clara | 13 |
| Infanta-San Lázaro | 15 | Castillo del Principe | 51 |
| Iglesia de Jesus Maria | 6 | Atalaya de los Bomberos del Com.º | |
| Monte, entre Amistad y Aguila | 15'5 | Calc. del Monte | 45'75 |
| Crucero de Monte y Rastro | 3'5 | Crucero Cerro-Palatino | 30'50 |
| Crucero de Camp.º y S. Rafael | 10'5 | | |

La diferencia entre la mayor pleamar y la menor bajamar es de 94 centímetros, en el Puerto de la Habana, pero la diferencia de las marcas ordinarias es de unos 73 centms.



O. P.

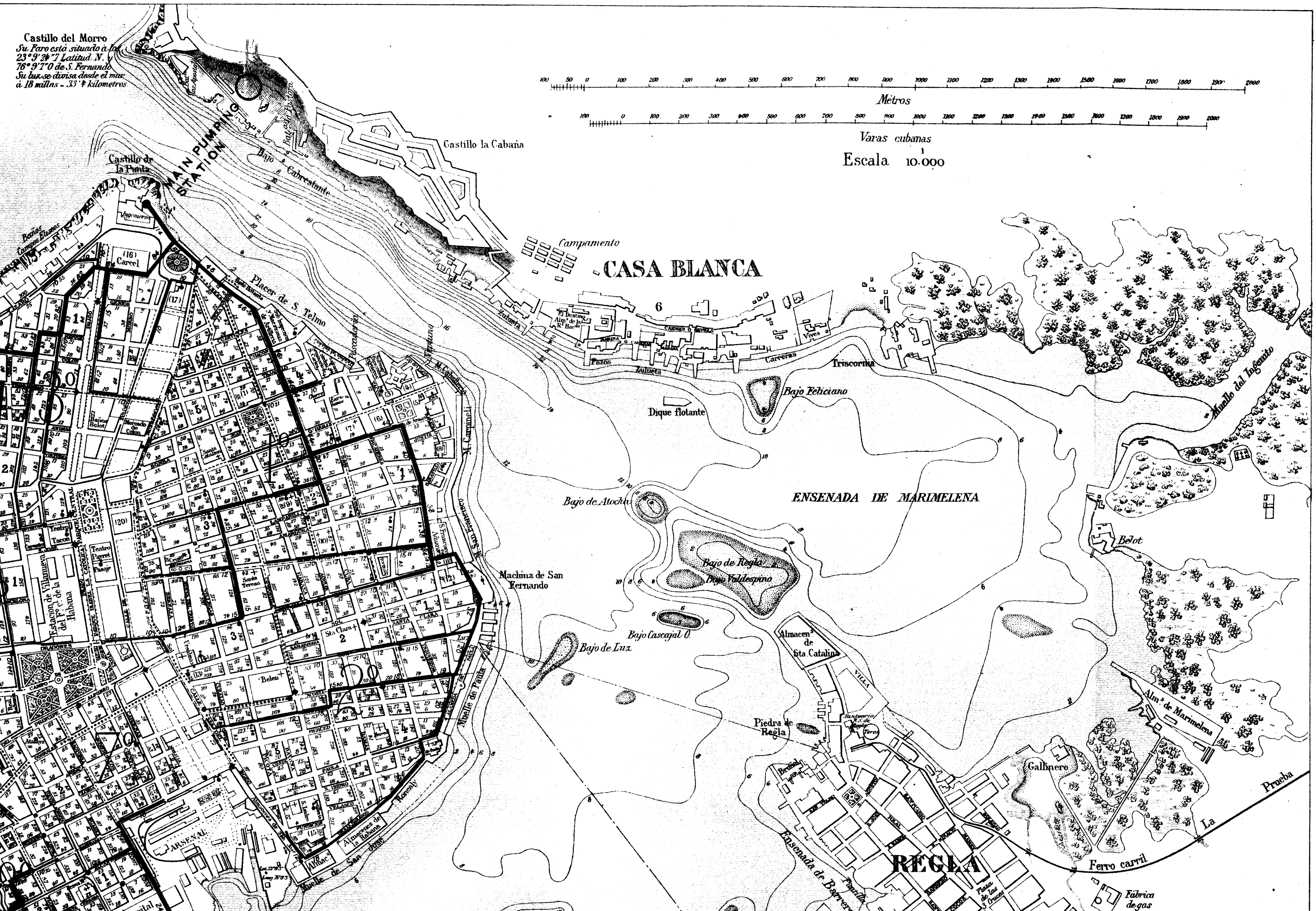
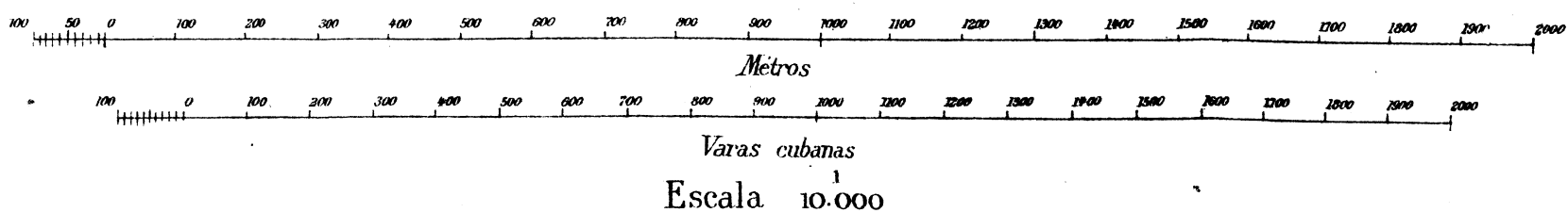
Serve

Showing Force

Sewerage System for Havana
Showing Force Mains and Main and intercepting sewers only.

[illegible]

Castillo del Morro
Su Faro está situado a las
23° 9' 24" 7 Latitud N.
76° 9' 10" de S. Fernando
Su luz se divisa desde el mar
a 16 millas - 33 1/2 kilómetros





POR

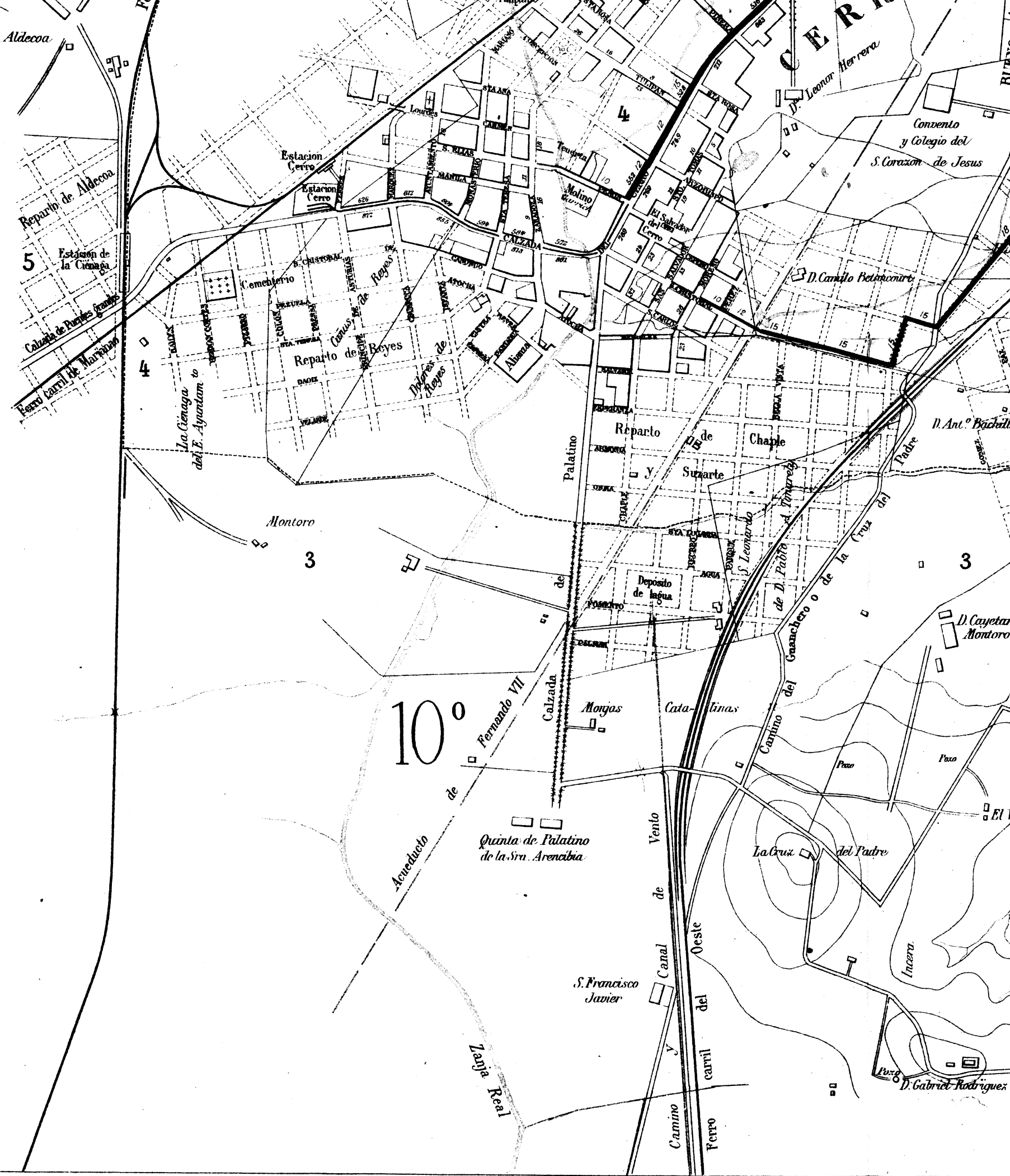
AGRIMENSOR Y MAESTRO DE OBRAS.

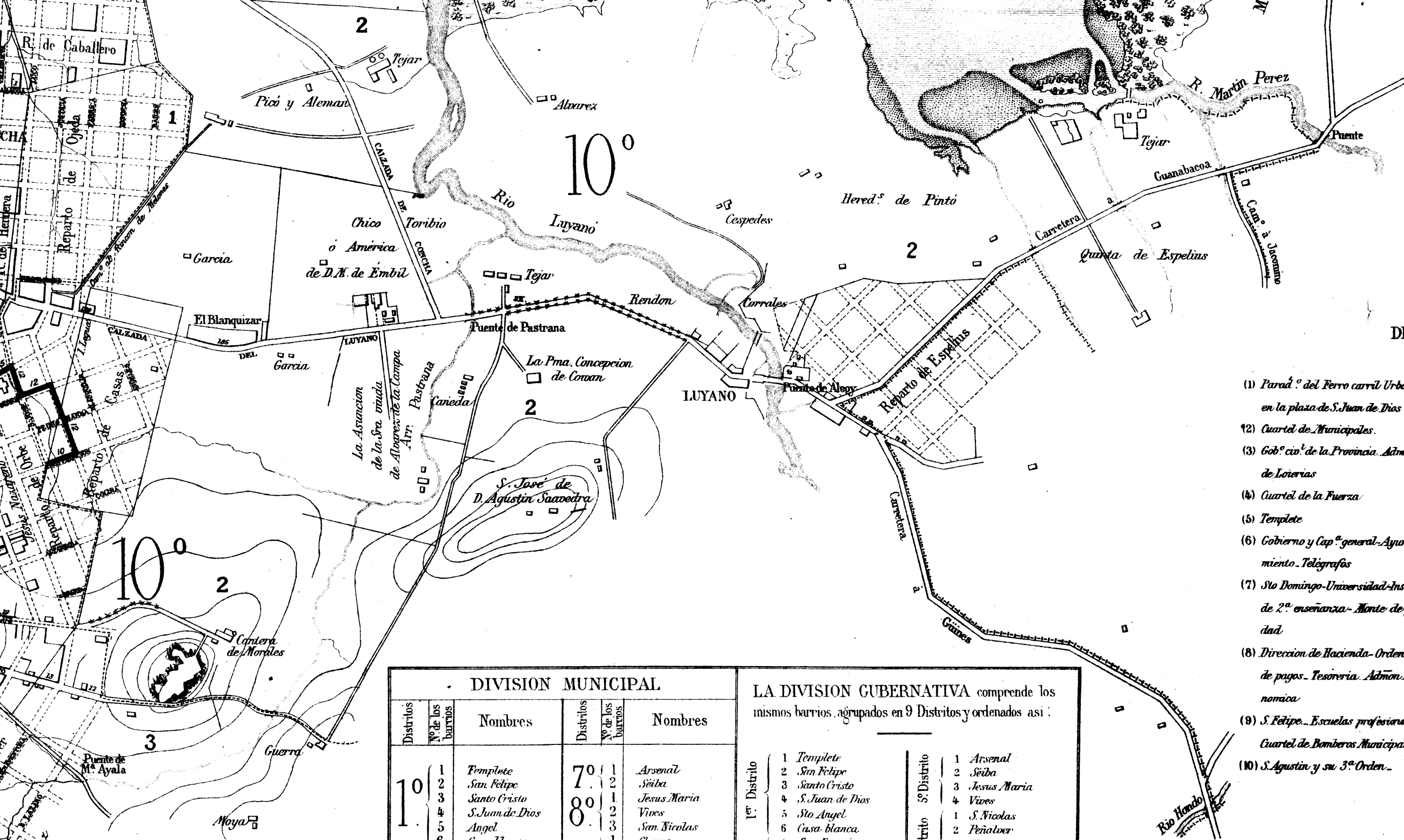
EDITOR: D. JOSE VALDEPARES.

Las curvas de igual sonda, dibujadas en el Puerto, indican la profundidad del agua de dos en dos metros, en baja mar, y están deducidas del sondeo verificado por O. públicas en 1874.

- | | | |
|---------------------------------------------|---------------------------------|------------------------|
| ● | Estac ^{ra} telegrafica | } Servicio de Bomberos |
| ■ | Caja de agua | |
| ✦ | Caja y sifon | |
| ● | Sifon | |
| <hr/> | | |
| | Perro carril en explotacion | |
| <hr style="border-top: 1px dashed black;"/> | | |
| | Idem en proyecto | |
| † | Parroquia | |
| - - - - | Limite Municipal | |
| <hr style="border-top: 1px dashed black;"/> | | |
| | Idem de Distrito municipal | |
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| | Idem de Barrio | |
| <hr style="border-top: 1px dashed black;"/> | | |
| +++++ | Idem de Parroquia | |

*Los de las barrias son de caracter romano,
mayores que las del Directorio: 1, 2, 3*





DIRECTORIO

- (1) Parád.º del Ferro carril Urbano, en la plaza de S. Juan de Dios
- (2) Cuartel de Municipales.
- (3) Gob.º civ.º de la Provincia. Adminis.º de Loterías
- (4) Cuartel de la Fuerza
- (5) Tempete
- (6) Gobierno y Cap.º general. Ayunta. miento. Telégrafos
- (7) Sto Domingo-Universidad-Instituto de 2.º enseñanza- Monte de piedad
- (8) Direccion de Hacienda- Orden.º de pagos. Tesoreria. Admon. Eco. nomica
- (9) S. Felipe. Escuelas profesionales. Cuartel de Bomberos Municipales
- (10) S. Agustin y su 3.º Orden.
- Academia de ciencias medicas, fisicas y naturales.
- (11) Admon. de Correas- Intervencion de Marina- Deposito hidrográfico
- (12) Comand.º grñl del Apostadero
- (13) Cuartelillo Bomb.º municipales
- (14) Cuartel Bomb.º del Comercio
- (15) Casa de Recogidas, de S. Juan Tepomuceno
- (16) Carcel- Presidio Hospital civil de S. Felipe y Santiago
- (17) Morgue o Necrasomio Obras municipales
- (18) Asilo de S. José, de Artes y Oficios
- (19) Teatro de Albizu, o de Lersundi
- (20) Casino español
- (21) Cuartel de la Guardia civil

| DIVISION MUNICIPAL | | | | LA DIVISION GUBERNATIVA comprende los mismos barrios, agrupados en 9 Distritos y ordenados así: | | | |
|--------------------|-------------------|-----------------|-----------|-------------------------------------------------------------------------------------------------|-----------------|-------------|-------------------|
| Distritos | Nº de los barrios | Nombres | Distritos | Nº de los barrios | Nombres | Distritos | Nº de los barrios |
| 1º | 1 | Tempete | 7º | 1 | Arsenal | 1º Distrito | 1 |
| | 2 | San Felipe | | 2 | Séiba | | 2 |
| | 3 | Santo Cristo | | 3 | Jesus Maria | | 3 |
| | 4 | S. Juan de Dios | | 4 | Vinos | | 4 |
| | 5 | Angel | | 5 | San Nicolas | | 5 |
| 2º | 6 | Casa blanca | 8º | 6 | Chavez | 2º Distrito | 6 |
| | 7 | San Francisco | | 7 | Pilar | | 7 |
| | 8 | Santa Clara | | 8 | Atares | | 8 |
| | 9 | Santa Teresa | | 9 | Pueblo nuevo | | 9 |
| | 10 | Paula | | 10 | Vedado | | 10 |
| 3º | 11 | S. Isidro | 9º | 11 | Principe | 3º Distrito | 11 |
| | 12 | Punta | | 12 | Villanueva | | 12 |
| | 13 | Colon | | 13 | Jesus del Monte | | 13 |
| | 14 | Monsestate | | 14 | Luyano | | 14 |
| | 15 | S. Leopoldo | 10º | 15 | Arroyo Apolo | 4º Distrito | 15 |
| 4º | 16 | S. Lazaro | | 16 | Cerro | | 16 |
| | 17 | Tacon | | 17 | Puentes grandes | | 17 |
| | 18 | Guadalupe | | 18 | Arroyo Naranjo | | 18 |
| | 19 | Marte | | 19 | Calvario | | 19 |
| 5º | 20 | Dragones | 11º | 20 | | 5º Distrito | 20 |
| | 21 | Penalver | | 21 | | | 21 |
| | 22 | | | 22 | | | 22 |
| 6º | 23 | | 12º | 23 | | 6º Distrito | 23 |
| | 24 | | | 24 | | | 24 |
| | 25 | | | 25 | | | 25 |

Puentes grandes, Arroyo Naranjo y Calvario estaban como Pedanias, no incluidas en los 9 Distritos.

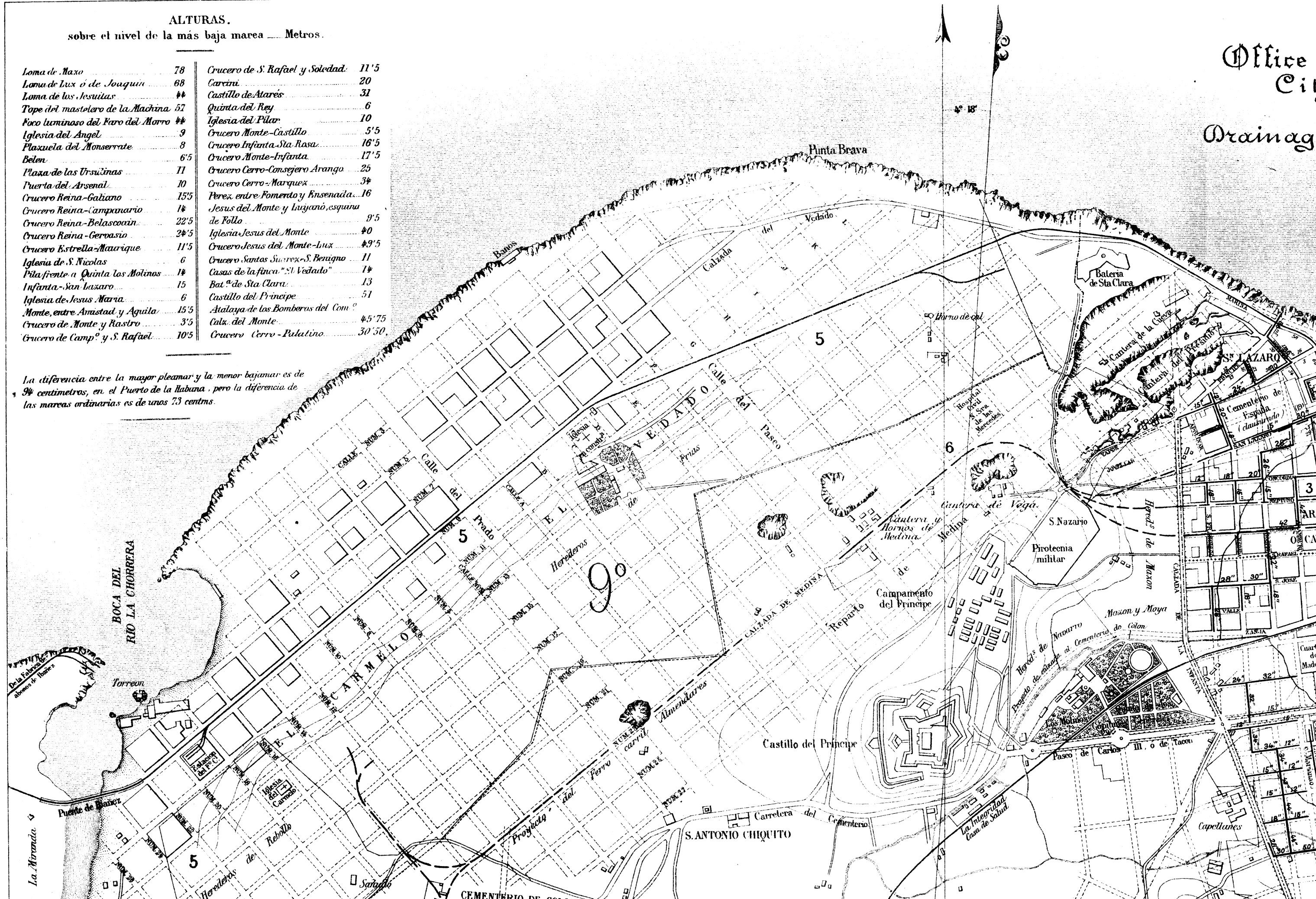
Office of Chief Engineer
 Division of Cuba.
 To accompany Report of June 30th, 1900.
W. M. Bush
 Major Corps of Engineers, U.S.A.
 Chief Engineer Division of Cuba.

ALTURAS.

sobre el nivel de la más baja marea — Metros.

| | | | |
|----------------------------------|------|------------------------------------|-------|
| Loma de Maxo | 78 | Crucero de S. Rafael y Soledad | 11'5 |
| Loma de Lux ó de Joaquín | 68 | Carcini | 20 |
| Loma de los Jesuitas | 44 | Castillo de Atarés | 31 |
| Tope del mastelero de la Machina | 57 | Quinta del Rey | 6 |
| Foco luminoso del Faro del Morro | 44 | Iglesia del Pilar | 10 |
| Iglesia del Angel | 9 | Crucero Monte-Castillo | 5'5 |
| Plazuela del Monserrate | 8 | Crucero Infanta Sta. Rosa | 16'5 |
| Belen | 6'5 | Crucero Monte-Infanta | 17'5 |
| Plaza de las Ursulinas | 11 | Crucero Cerro-Comsejero Arango | 25 |
| Puerta del Arsenal | 10 | Crucero Cerro-Marquez | 34 |
| Crucero Reina-Galiano | 15'5 | Perez entre Fomento y Ensenada | 16 |
| Crucero Reina-Campanario | 14 | Jesus del Monte y Luizano, esquina | |
| Crucero Reina-Belascoain | 22'5 | de Folio | 9'5 |
| Crucero Reina-Gervasio | 24'5 | Iglesia Jesus del Monte | 40 |
| Crucero Estrella-Maurique | 11'5 | Crucero Jesus del Monte-Lux | 49'5 |
| Iglesia de S. Nicolas | 6 | Crucero Santos Suarez-S. Benigno | 11 |
| Pila frente a Quinta los Molinos | 14 | Casas de la finca "El Vedado" | 14 |
| Infanta-San Lázaro | 15 | Bat.ª de Sta. Clara | 13 |
| Iglesia de Jesus Maria | 6 | Castillo del Principe | 51 |
| Monte, entre Amstad y Aguila | 15'5 | Atalaya de los Bomberos del Com.º | |
| Crucero de Monte y Rastro | 3'5 | Calz. del Monte | 45'75 |
| Crucero de Camp.º y S. Rafael | 10'5 | Crucero Cerro-Pulativo | 30'50 |

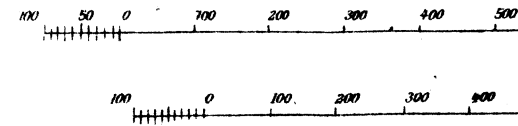
La diferencia entre la mayor pleamar y la menor bajamar es de 94 centímetros, en el Puerto de la Habana, pero la diferencia de las mareas ordinarias es de unos 73 centms.



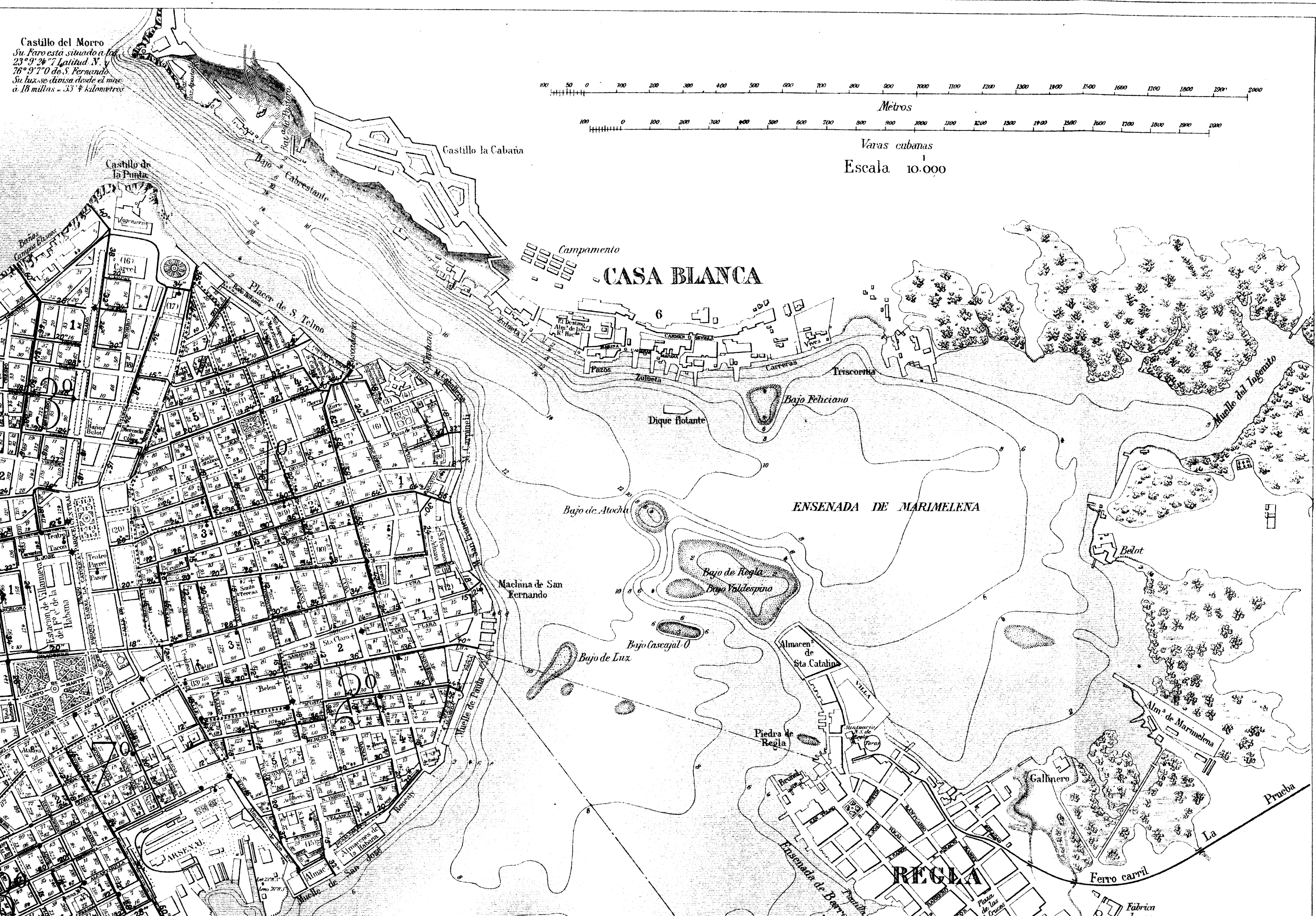
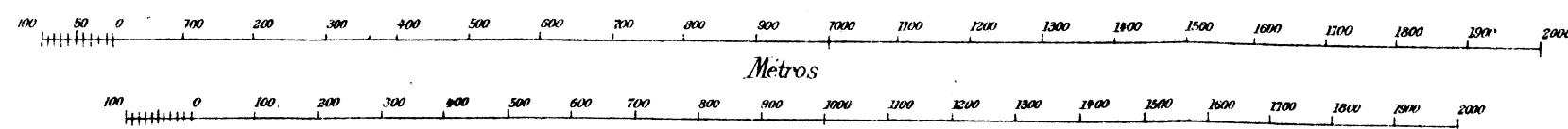
Office of Chief Engineer City of Havana

Drainage System for Havana

Castillo del Morro
Su Faro está situado a las
23° 3' 24" Latitud N.
76° 9' 7" O de S. Fernando
Su luz se divisa desde el mar
a 18 millas = 33 1/4 kilómetros



Castillo del Morro
Su Faro está situado a las
23° 9' 24" N. Latitud N.
76° 9' 7" O de S. Fernando
Su luz se divisa desde el mar
a 18 millas = 33 1/2 kilómetros





PLANO
DE LA
HABANA

POR
D. ESTEBAN T. PICHARDO,



PLANO DE LA HABANA

POR
D. ESTEBAN T. PICHARDO,

AGRIMENSOR Y MAESTRO DE OBRAS.

EDITOR: D. JOSÉ VALDEPARES.

Para la formación de este Plano, se han tenido presentes: el publicado por el Excmo. Ayuntamiento, el del Puerto por los Ingenieros de Obras publicas y otros debidos a los Sres. D. Mariano Carles, D. José Ocampo, D. J. Manuel Alvaro, D. Alberto de Castro, D. Antonio Ariza, D. José Lopez Trigo, D. José C. del Castillo, D. Simon Teja &c; cuyos trabajos ha combinado el Autor del presente, añadiendo los que practicó expreso sobre el terreno.

Las curvas de igual sonda, dibujadas en el Puerto, indican la profundidad del agua de dos en dos metros, en baja mar, y están deducidas del sondeo verificado por O. publicas en 1874.

- Estac^a telegráfica
- Caja de agua
- Caja y sifón
- Sifón
- Ferrocarril en explotación
- Idem en proyecto
- Parroquia
- Límite Municipal
- Idem de Distrito municipal
- Idem de Barrio
- Idem de Parroquia

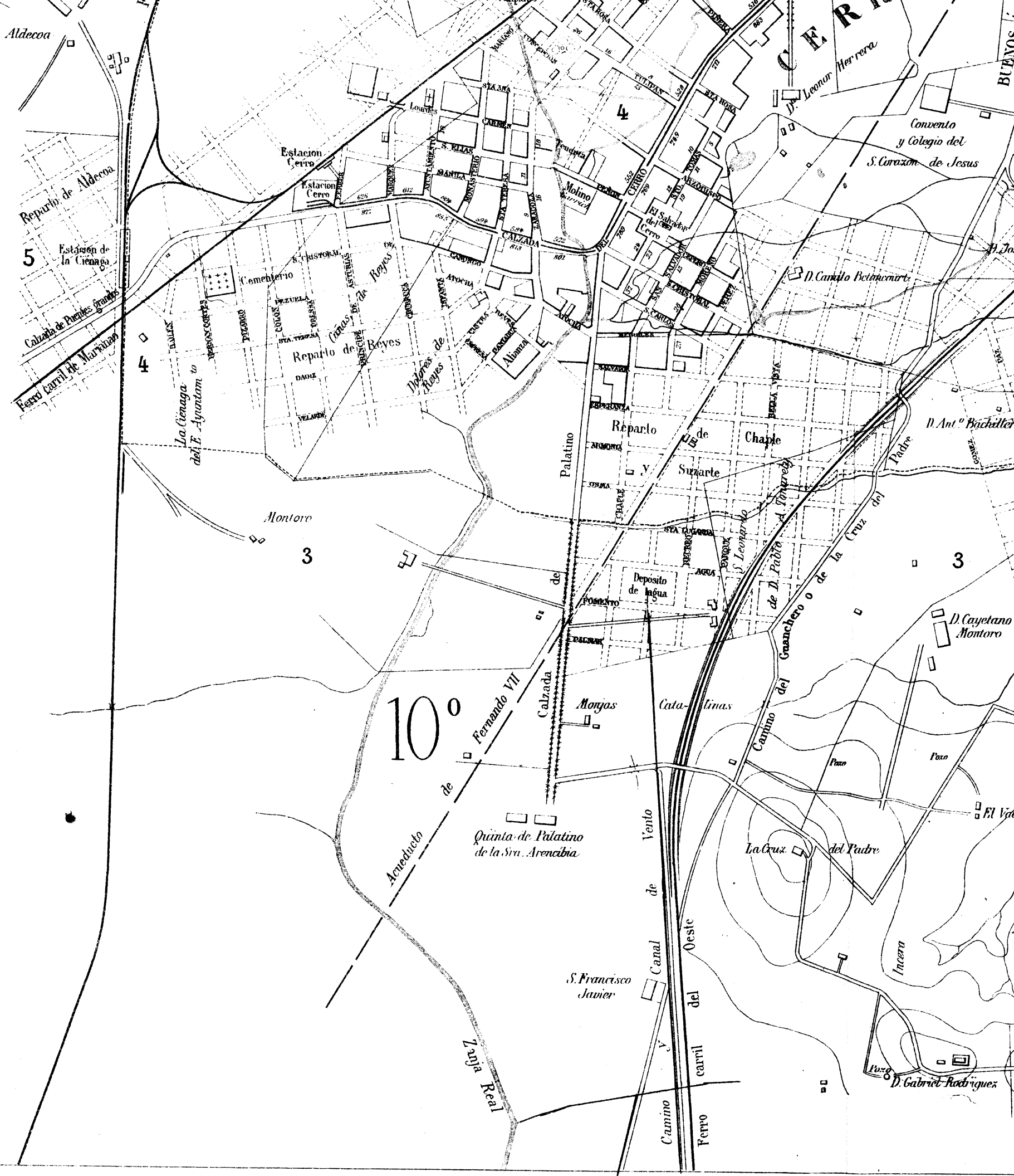
Servicio
de Bomberos

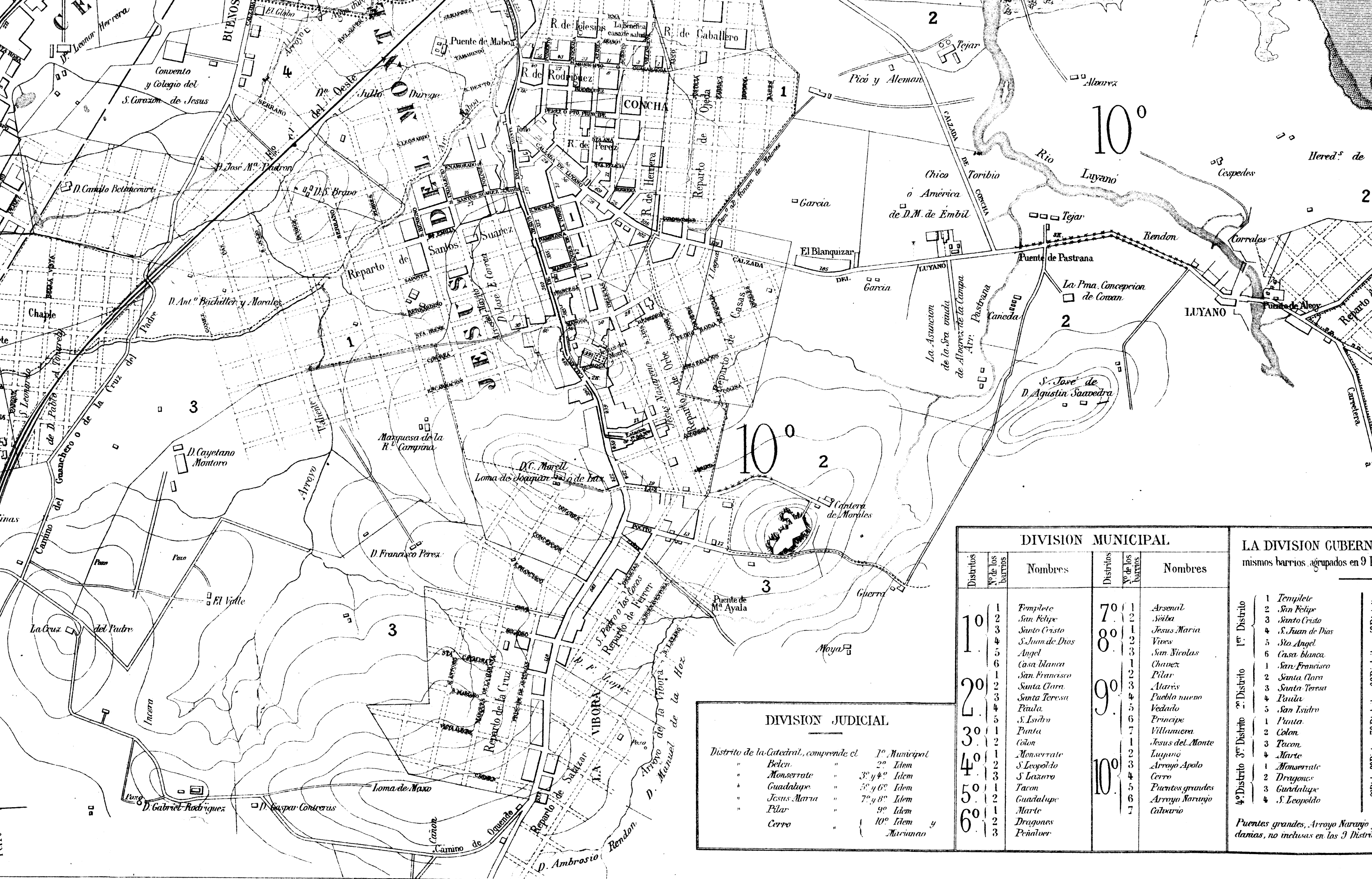
Los números de las casas corresponden al último de cada frente de manzana y están escritos en carácter italico, como 1, 2, 3, 4

Las que se refieren a la numeración del Directorio, están escritas en carácter romanos, y entre paréntesis: (1) (2) (3) (4)

Los ordinales de los Distritos municipales son de carácter capitales y tamaño grande: 1^o

Los de los barrios son de carácter romano, mayores que los del Directorio: 1, 2, 3

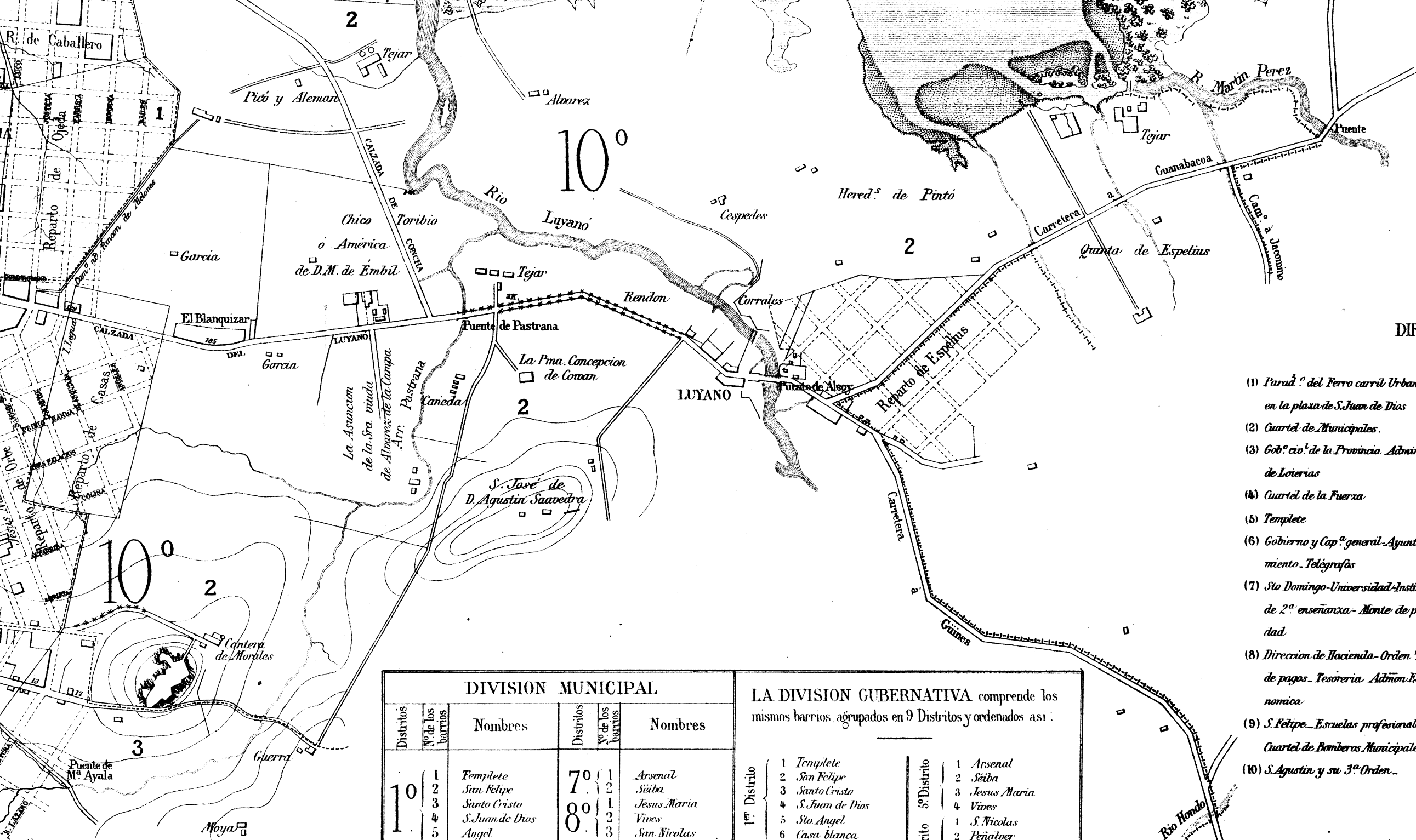




| DIVISION JUDICIAL | | | |
|---------------------------------------|-------------|---|---------------------|
| Distrito de la Catedral, comprende el | | | |
| " | Belen | " | 1° Municipal |
| " | Monserate | " | 2° Idem |
| " | Guadalupe | " | 3° y 4° Idem |
| " | Jesus Maria | " | 5° y 6° Idem |
| " | Pilar | " | 7° y 8° Idem |
| " | Cerro | " | 9° Idem |
| " | | " | 10° Idem y Mariuano |

| DIVISION MUNICIPAL | | | |
|--------------------|-------------------|-----------------|--|
| Distritos | Nº de los barrios | Nombres | |
| 1º | 1 | Templete | |
| | 2 | San Felipe | |
| | 3 | Santo Cristo | |
| | 4 | S. Juan de Dios | |
| | 5 | Angel | |
| | 6 | Casa blanca | |
| | 7 | San Francisco | |
| | 8 | Santa Clara | |
| | 9 | Santa Teresa | |
| | 10 | Paola | |
| | 11 | S. Isidro | |
| | 12 | Punta | |
| | 13 | Colon | |
| | 14 | Monserate | |
| | 15 | S. Leopoldo | |
| | 16 | S. Lazaro | |
| | 17 | Tacon | |
| | 18 | Guadalupe | |
| | 19 | Marte | |
| | 20 | Dragones | |
| | 21 | Penalver | |

| LA DIVISION GUBERNATIVA | | | |
|-------------------------------|---|-----------------|--|
| mismos barrios agrupados en 9 | | | |
| 1º Distrito | 1 | Templete | |
| | 2 | San Felipe | |
| | 3 | Santo Cristo | |
| | 4 | S. Juan de Dios | |
| | 5 | S. Angel | |
| | 6 | Casa blanca | |
| | 7 | San Francisco | |
| | 8 | Santa Clara | |
| | 9 | Santa Teresa | |
| 2º Distrito | 1 | Paola | |
| | 2 | S. Isidro | |
| | 3 | Punta | |
| | 4 | Colon | |
| | 5 | Tacon | |
| | 6 | Marte | |
| | 7 | Monserate | |
| | 8 | Dragones | |
| | 9 | Guadalupe | |
| 3º Distrito | 1 | S. Leopoldo | |
| | 2 | Penalver | |
| | 3 | Puentes grandes | |
| | 4 | Arroyo Narayon | |
| | 5 | Caltavio | |



DIRECTORIO

- (1) Parada del Ferrocarril Urbano, en la plaza de S. Juan de Dios
- (2) Cuartel de Municipales
- (3) Cob. ex. de la Provincia. Adminis. de Loerías
- (4) Cuartel de la Fuerza
- (5) Tempete
- (6) Gobierno y Cap. general. Ayunta. miento. Telégrafos
- (7) Sto Domingo-Universidad-Instituto de 2.ª enseñanza-Monte de piedad
- (8) Direccion de Hacienda-Orden. de pagos. Tesoreria. Admon. Económica
- (9) S. Felipe. Escuelas profesionales. Cuartel de Bomberos Municipales
- (10) S. Agustín y su 3.ª Orden.
- Academia de ciencias medicas, fisicas y naturales.
- (11) Admon. de Correas. Intervencion de Marina. Deposito hidrográfico
- (12) Comand. en jefe del Apostadero
- (13) Cuartelillo Bomb. municipales
- (14) Cuartel Bomb. del Comercio
- (15) Casa de Recogidas, de S. Juan Nepomuceno
- (16) Carcel. Presidio Hospital civil de S. Felipe y Santiago
- (17) Morgue o Necroscopio Obras municipales
- (18) Asilo de S. José, de Artes y Oficios
- (20) Teatro de Alhiza, o de Lercundi
- (21) Casino español
- (22) Cuartel de la Guardia civil

| DIVISION MUNICIPAL | | | | | |
|--------------------|-------------------|-----------------|------------|-------------------|-----------------|
| Districtos | Nº de los barrios | Nombres | Districtos | Nº de los barrios | Nombres |
| 1º | 1 | Templete | 7º | 1 | Arsenal |
| | 2 | San Felipe | | 2 | Sibba |
| | 3 | Santo Cristo | | 3 | Jesus Maria |
| | 4 | S. Juan de Dios | | 4 | Vives |
| | 5 | Angel | | 5 | San Nicolas |
| | 6 | Casa blanca | | 6 | Chavez |
| 2º | 1 | San Francisco | 8º | 1 | Pilar |
| | 2 | Santa Clara | | 2 | Atarés |
| | 3 | Santa Teresa | | 3 | Pueblo nuevo |
| | 4 | Paula | | 4 | Vedado |
| | 5 | S. Isidro | | 5 | Príncipe |
| 3º | 1 | Punta | 9º | 6 | Villumiera |
| | 2 | Colon | | 7 | Jesus del Monte |
| 4º | 1 | Monserate | 10º | 1 | Luyano |
| | 2 | S. Leopoldo | | 2 | Arroyo Apolo |
| | 3 | S. Lazaro | | 3 | Cerro |
| 5º | 1 | Tacon | | 4 | Puentes grandes |
| | 2 | Guadalupe | | 5 | Arroyo Narayjo |
| 6º | 1 | Marte | | 6 | Cahurío |
| | 2 | Dragones | | | |
| | 3 | Peñalver | | | |

LA DIVISION GUBERNATIVA comprende los mismos barrios, agrupados en 9 Districtos y ordenados así:

| | | | |
|-------------|-------------------|-------------|-------------------|
| 1º Distrito | 1 Tempete | 5º Distrito | 1 Arsenal |
| | 2 San Felipe | | 2 Sibba |
| | 3 Santo Cristo | | 3 Jesus Maria |
| | 4 S. Juan de Dios | | 4 Vives |
| | 5 Sto Angel | | 1 S. Nicolas |
| | 6 Casa blanca | | 2 Peñalver |
| 2º Distrito | 1 San Francisco | | 3 Chavez |
| | 2 Santa Clara | | 4 Pilar |
| | 3 Santa Teresa | | 5 Atares |
| | 4 Paula | | 1 S. Lazaro |
| | 5 San Isidro | | 2 Pueblo nuevo |
| 3º Distrito | 1 Punta | | 3 Principe |
| | 2 Colon | | 4 Vedado |
| | 3 Tacon | | 1 Jesus del Monte |
| | 4 Marte | | 2 Luyano |
| 4º Distrito | 1 Monserate | | 3 Arroyo Apolo |
| | 2 Dragones | | 1 Villanueva |
| | 3 Guadalupe | | 2 Cerro |
| | 4 S. Leopoldo | | |

Puentes grandes, Arroyo Narayjo y Cahurío estaban como Peñalver, no incluidas en los 9 Districtos.

| DIVISION JUDICIAL | | |
|----------------------------------------|--------------------|--|
| Districto de la Catedral, comprende el | 1º Municipal | |
| " Belen " | 2º Idem | |
| " Monserate " | 3º y 4º Idem | |
| " Guadalupe " | 5º y 6º Idem | |
| " Jesus Maria " | 7º y 8º Idem | |
| " Pilar " | 9º Idem | |
| " Cerro " | 10º Idem y Mariuan | |

Office of Chief Engineer
Division of Cuba.

To accompany Report of June 30th, 1900.

W. M. Clark

Major Corps of Engineers, U.S.A.
Chief Engineer Division of Cuba.

The harbor covers an area of about 1,500 acres, and has a depth of between 30 and 50 feet of water in the channel through the entrance. In the upper portions of the harbor the depth of water is much less.

The harbor receives the surface water from a drainage area of about 26 square miles contributed by several small streams, the principal ones being the Luyano, Agua Dulce, and Matadero creeks. The mean rise and fall of the tide in the harbor is 1 foot.

At the upper end of the harbor marshes and low lands have been formed by material brought down by the streams and by the accumulation of vegetable growth.

In the suburbs of Jesus del Monte and Cerro are several small streams and ditches leading from the Zanja Real, which latter is supplied with water from the Almen-dares River. These small streams and ditches are still in use in many instances for conducting water for irrigation.

The substrata of the city is largely composed of limestone and coral rock formation, varying from 2 to 10 feet below the surface of the ground. This rock being of a porous nature probably does not contain much ground water excepting below tide elevation.

On the northern slope of the city are a number of stone quarries that have furnished a large amount of building material for the city, and it will probably be many years before these localities will be occupied for residential or business purposes.

A ridge running east and west divides the old part of the city nearly on the line of Calle de Reina and Carlos III; the northern slope draining toward the Gulf, while the southern slope drains toward the harbor. This ridge reaches a height of 40 feet above tide water. In some portions of the suburban districts the ground rises to about 120 feet above tide water. Generally throughout the entire city the topography affords good natural grades for drainage of surface water.

EXISTING CONDITIONS.

The water supply of the city of Habana is abundant, pure water being obtained from springs in the hills at Vento, about 8 miles distant, and is brought to the city by means of an aqueduct leading from the springs to the Palatino reservoir, from which it is delivered throughout the city in iron pipes.

It is stated that the quantity of water supplied daily to the city averages about 35,419,000 gallons, or 173 gallons per capita. This quantity of water is greater than is ordinarily consumed per capita for cities of the size of Habana, and no doubt a large percentage of it is wasted.

No regularly designed system of sewerage or drainage has ever been constructed in Habana. Stone drains, of rectangular blocks of coral rock laid on the natural soil with stone covering, have been built in the old part of the city, but they were built in such a manner as to be quite deficient for sanitary purposes, and not of much value for removing the storm water from the streets. The overflowing of the streets and flooding of the buildings in certain parts of the city are of common occurrence during heavy storms. These drains also receive the sewage from dwellings and the overflow from the cesspools, discharging into the harbor or Gulf, as the case may be. There being no lining to the bottom of the drains, the soakage of foul liquids into the soil must be very great. The interior of these drains being rough, uneven, and without proper grades, a large amount of filthy matter is retained in them, which putrefies and gives off through the catch-basins or inlets odors which are not only extremely disagreeable, but are more or less detrimental to the health of the citizens. No traps are provided at the catch-basins or inlets to prevent the escape of these foul odors or sewer gas, nor are these so-called sewers or drains ventilated to any extent except through the inlets.

In the suburbs of Jesus del Monte and Cerro no sewers or drains exist, but the gutters adjoining the sidewalks are used for conveying away the liquid wastes. Many of the small streams and ditches in the suburbs are used as sewers, some of them being extremely filthy and dangerous to public health.

At the time of my visit to Habana every possible precaution was being taken by the military authorities to prevent the fouling of the streams and gutters by cleaning and disinfecting them at frequent intervals.

The scrupulous care which was also taken in keeping the streets clean had a decidedly favorable effect upon the condition of these gutters.

POPULATION.

The population of the city at the present time is approximately 217,000, located as follows:

In the old portion of the city, from the harbor to Calzada de la Infanta, 188,000;

in Jesus del Monte and Cerro, 17,000; Casa Blanca, 2,000; El Vedado and Carmelo, 7,000; and the suburbs, 3,000. Regla, although not a part of the city proper, and not included in the above, is estimated at 3,000.

Some portions of the old part of the city are extremely dense in population, especially in the vicinity of Cardenas, Cienfuegos, and Someruelos streets, where the population numbers as high as 246 people to the acre, while the general average of population of this part of the city is about 125 people to the acre. In the suburban districts the population does not average at the present time more than 7 people to the acre, but there are localities where the population is much in excess of this. The future growth of the city will doubtless be largely in the suburban districts, and no material increase in the population need be looked for in the old part of the city, it being already so densely populated.

In designing a system of sewerage for a large and growing city it is essential that the future as well as the present requirements should be taken into consideration.

So far as is known no reliable records of the past growth of the city are obtainable. Such records would be very useful in estimating for the future; but as they are not available it is necessary to estimate the probable future population by basing it largely upon judgment and upon records of other cities of similar size, both American and insular.

RAINFALL AND RUN-OFF FROM STORMS.

Rainfall records have been obtained from the Observatorio de Belen, on Compostela street, for the rainy season of each year, dating back to May 23, 1885, and the same are believed to be fairly accurate and reliable. Other data concerning severe storms from the year 1861 to the present time were also obtained from the same source.

The most important rain storms of which we have any records occurring during the last thirty-eight years are shown on a diagram accompanying this report.

These records show that the severest storm (occurring October 12, 1874) lasted two and one-half hours, during which 5.25 inches of rain fell, at an average rate of 2.10 inches per hour. Other storms are recorded at the rate of 2 inches per hour for forty-five minutes, 2.40 inches per hour for five minutes, and 2.32 inches per hour for fifteen minutes. At the United States Weather Bureau station there are records which show that rain has fallen at the rate of 3.07 inches per hour for ten minutes, and at 2.74 inches per hour for twenty-three minutes. These are the heaviest rainfalls that have been recorded for Habana, and it is to be expected that such storms may again occur, although such are not common.

With paved streets and nearly all the area between the streets covered with buildings, as is the case in Habana, a very large percentage of rainfall may be expected to run off. The amount of the run-off also depends largely upon the slope and size of the area drained.

OBJECT TO BE OBTAINED.

It is hardly necessary to enter into a discussion regarding the existing needs of a well-designed and properly constructed system of sewerage and drainage for the city of Habana. This is generally admitted by all who are interested in the health of the citizens and the welfare and growth of the city.

One object to be attained is to remove as quickly as possible all liquid wastes from dwellings, hotels, stores, and other buildings, and to dispose of these wastes in such a manner that no possible harm can arise from them. Adequate provision should also be made for the prompt removal of storm water falling on the streets, roofs of buildings, and courtyards.

For the sake of avoiding confusion, the terms "sewers" and "sewerage" are applied to the part of the works relating to the removal of sewage proper, and "drains" and "drainage" are applied to the part of the works relating to the removal of storm water.

In designing works of the magnitude necessary for Habana, due regard for economy must be had, both as to the first cost of construction, and also to the cost of maintenance when completed and in operation.

Two general methods of sewerage and drainage are in use, one of which is known as the combined system—taking, in the same set of sewers, storm water from the streets, courtyards, and roofs, including sewage from dwellings and buildings. The other is known as the separate system—admitting sewage only to the sewers, letting the storm water flow off upon the surface of the street, or providing for its removal by means of storm drains. Where the separate system of sewers is supplemented quite extensively by storm drains the combination is often termed the double system.

METHODS OF SEWAGE DISPOSAL.

The methods of sewage disposal commonly adopted may be spoken of as dilution, irrigation and filtration, and chemical precipitation.

(a) *Dilution*.—Dilution contemplates discharging the sewage, in its crude or unclarified state, into some near water course or large body of water. This is usually by far the cheapest method of disposal, and where the flow of the stream or body of water is large enough to sufficiently dilute the sewage so that no nuisance will result this method of disposal is admissible. The dilution necessary is dependent upon the existing circumstances and conditions of each place.

(b) *Irrigation and filtration*.—Irrigation upon land consists in discharging the crude sewage upon the soil, the coarser material being left on the surface of the ground, while the more minute portions of the sewage pass into the earth to a greater or less depth, depending upon the fineness of the particles in the sewage and coarseness of the soil. The liquid, freed from the matter in suspension, descends still further into the ground, coming in contact with the air in the earth. The impurities which the sewage contains are thereby oxidized; that is, purified by the action of bacteria, which are dependent for life upon the oxygen contained in the air. The purified liquid may descend still lower, or it may be carried off in underground drains laid for that purpose. The insoluble matter retained in the soil is also oxidized or decomposed by slow combustion, and is thereby reduced to a fine powder and mingled with the elements in the earth.

Distinction, however, exists between irrigation and filtration. In irrigation only so much sewage is applied to the land as will be beneficial to the vegetation. In filtration the quantity applied is governed by the amount the earth will purify, regardless of its effects on the growing crops, if there are any under cultivation. Materials differ greatly in their powers of purifying, coarse sandy or gravelly material being much better than that which is fine or compact. In irrigation usually the prime object is the profit that may be derived from the growing crops, whereas in filtration the prime object is the purification of the sewage.

In irrigation a much larger area is required to dispose of a given quantity of sewage than where filtration is practiced. The ground to be used in the case of filtration requires more preparation, such as grading, underdraining, etc., than for irrigation.

Filtration may be classified as continuous or intermittent. Continuous filtration implies a continuous application of the sewage to the filter beds, while in intermittent filtration the sewage is applied intermittently, or periodically, thereby allowing air to follow each application of sewage through the ground. If the air is cut off, as is the case by continuous filtration, particularly where a large quantity of sewage is applied, the bacteria die and purification is interrupted. If, on the other hand, the application of the sewage is intermittent, the air, following the sewage through the soil, supplies the oxygen necessary for purification. It is therefore found that far better results are obtained, and that with less area of land, by an intermittent rather than by a constant application of sewage.

(c) *Chemical precipitation*.—Chemical precipitation consists in collecting the sewage in tanks, having just previously mixed with it certain chemicals, the result of which is to precipitate all matters in suspension and a portion of the impurities in solution, leaving a comparatively clear and odorless effluent, which may be discharged into any stream (from which water is not taken for domestic purposes) without causing a nuisance, provided the quantity of water, or flow of the stream, is sufficiently large to properly dilute the effluent. A semifluid mass collects at the bottom of the tanks, called sludge, which may be drawn off, or pumped out onto beds, to drain and dry out; or it may, by means of filter presses, be deprived of so much of its moisture as to enable handling it in carts or otherwise; and it may be used for filling low lands, or as a fertilizer, if it is found to possess any value as such. The chemicals most employed are lime or sulphate of alumina, or both.

To practice chemical precipitation requires, as above stated, tanks for collecting and retaining the sewage for treatment. These tanks vary in dimensions according to the quantity of sewage to be treated. They may be from 12 to 50 or more feet in width, 30 to 100 or more feet in length, and usually from 6 to 8 feet in depth. More or less machinery, such as chemical mixers, sludge pumps, filter presses, etc., is required.

In addition to the three principal methods of sewage disposal above described some mention should be made of a system of sewage purification which has within a few years been experimented with and adopted in a few places in England; that of the "septic system," so called.

This system, briefly described, consists of collecting the sewage in an underground tank, practically air-tight, and from which the light is also excluded. The tank is built of masonry and is designed to hold from one to two days' flow of sewage. The

sewage is retained in the tank usually twenty-four hours, during which time it undergoes fermentation, which is caused by the action of bacteria in the sewage. A scum 2 or 3 inches in thickness soon forms on the surface. This scum shortly sinks to the bottom of the tank, portions of which are again carried to the surface by the formation of gases in the material, which gases are the result of the working of the bacteria.

The repeated rising and settling of this scum results in the deposit of a fine powdery mass at the bottom of the tank, which, it is claimed, is so slight in quantity as to require removing only at very long intervals, say of a year or more. The effect on the sewage is to reduce and separate, to a great degree, the solids in suspension from the water contained in the sewage, forming a fairly clear effluent. This effluent is drawn off from the tanks and run into filter beds. These beds may be built of different kinds of materials, such as burnt clay, broken stone, coke, or sand. The filter beds may vary in thickness, but are usually built from 3 to 6 feet in depth and underdrained. The underdrains are provided with gates so constructed that they may be entirely closed to prevent the escaping of the effluent from them. The filter beds are then filled with the effluent from the septic tanks and allowed to remain in this condition for two hours, after which the underdrains are opened, and the effluent permitted to escape through them. The beds are then drained and allowed to stand empty for three or four hours, when they are again ready for filling and the operation thus described is repeated.

By this method of treatment it is claimed that one acre of land may be made to purify 500,000 to 1,000,000 gallons of sewage per day.

The purification of the sewage by the septic system is due to the action of bacteria of two classes: One class is known as "anaerobic," and the other as "aerobic." The former class is found in large quantities in the sewage contained in the septic tanks, and does its work best where light and oxygen are absent. The latter class is contained principally in the filter bed, and, on the other hand, seems to require light and oxygen, and can not well work without these conditions.

It is claimed that the clarification brought about in the tank is equal to or better than that obtained by chemical treatment, producing a comparatively clear and odorless effluent, and that, too, without the cost of chemicals and also without the accumulation of sludge. The saving in the cost of chemicals and in the expense of pressing and disposing of sludge are great items claimed in favor of the septic system over that of chemical precipitation.

The septic system, as heretofore stated, is being used to a limited extent in England, and it has also been recently introduced into the United States in one or two instances; but it is somewhat experimental as yet, although so far the reports on this method of sewage disposal are encouraging.

With reference to either irrigation or filtration, I was unable by my examinations to find suitable land, in sufficient quantities, properly located to make admissible the adoption of either of these methods of disposal.

Chemical precipitation would be expensive in its first cost as well as in the cost of maintenance, and as this method would not remove more than one-half the organic matter in the sewage, the effluent could not with safety be discharged into the harbor, and it does not seem necessary at the present time to resort to this method of treatment for disposal into the Gulf. As it would seem unnecessary to further discuss these various methods of disposing of the sewage, its disposal by dilution into the Gulf of Mexico at some convenient and suitable point is therefore now considered.

OUTFALL SEWER.

Three locations for an outfall sewer into the Gulf on the north shore have been carefully considered, namely: At Punta Brava, at a point 2,000 feet west of the Almendares River, and at a point about 3,500 feet east of El Moro. Float observations were made at these points in order to determine as far as possible the direction of the tidal currents.

(a) *Punta Brava project.*—The plan contemplated for disposal by dilution at Punta Brava is to collect all the sewage from the city at a pumping station to be built on the point and pump it into the Gulf through iron pipes, discharging about 600 feet off shore.

The courses taken by the floats at Punta Brava were very irregular, some of them stranding on the shore, others following east or west and parallel with the coast line, while a few went to the northward. The observations made here with the floats show that at certain times, depending upon wind and tide, floating matter found in the sewage, if discharged 600 feet off the coast at this point, would be liable to strand on the shore, where it would soon become offensive.

From a study of the float observation made at this point, and from a careful examination of the surroundings, it is my opinion that it would not be advisable to

discharge the sewage of Habana at Punta Brava, unless discharged 2,000 feet offshore. At this distance it would become so thoroughly diluted and disintegrated by the action of the waves there would be little or no danger of the sewage becoming offensive. But the depth of water at 2,000 feet from the shore is 140 feet, which renders it impracticable to lay an outfall sewer that distance from the shore.

(b) *Almendares project*.—If the sewage from the city at the present time could be discharged into the Gulf west of the Almendares River 600 feet offshore, no trouble need be feared, as this region is not yet built up and it is quite doubtful if it will be occupied for a long time to come.

To reach the outfall at the point west of the Almendares River it is proposed to locate the pumping station near San Lazaro, where all the sewage could be collected, and there raised by the pumps to a larger sewer to be built near the present railway line, or in Ninth street, which would take the sewage by gravity to the outfall, crossing the river by an inverted siphon.

Float observations at this point, to determine the direction of the currents, were taken on February 8 and 9, 1900. These observations were not as extensive as those taken at the other locations, but during these two days the general direction of the floats was to the northeast, and far enough away to prevent any chance of returning, but there would undoubtedly be times when the currents would set in toward the shore, as was the case at Punta Brava.

The distance between San Lazaro and the outfall sewer is so great that the cost of a force main and sewer in Ninth street would be more expensive than that of the El Morro project, which is hereafter described.

The north shore from Punta Brava to the Almendares River is likely to become more and more residential in the future, therefore no sewage should be discharged into the Gulf along these shores.

(c) *El Morro project*.—Float observations at this point show that the winds and currents will take sewage in either direction east or west, but that very little if any will be brought back and deposited on the shore, and none of it will be carried into the harbor.

From a careful study of all the float observations, and from examinations on the ground, it is my opinion that the sewage from Habana can be safely discharged into the Gulf 600 feet offshore about 3,500 feet east of El Morro without being offensive or in any way menacing the public health.

The estimated cost of bringing the sewage to this point east of El Morro is greater than would be the case if discharged at Punta Brava 600 feet offshore, but not so great as it would be if taken to the point 2,000 feet west of the Almendares River.

To reach the proposed outfall east of El Morro it is proposed to concentrate the sewage at some convenient point on the west side of the harbor and take it across, either in a tunnel or in a submerged pipe, to the pumping station to be located on the east side, from which it would be pumped into a sewer built in tunnel through the ridge south of El Morro to the outfall.

Soundings were taken across the harbor from La Punta to El Morro, and at the foot of O'Reilly and Obispo streets across to Casa Blanca in order to determine the best feasible route for a tunnel or submerged pipes.

The uncertainty regarding the depth of rock at La Punta, as is shown by the soundings, renders it impracticable to drive a tunnel under the harbor for the entire distance, but by means of cofferdams a tunnel could be driven part way from each side, and these tunnels connected with iron pipes. The expense of so doing, however, would be considerably greater than trenching and laying a masonry lined pipe for the entire distance across and under the harbor bottom.

The situation at the foot of O'Reilly and Obispo streets is better adapted on some accounts for crossing the harbor with submerged pipes or with a tunnel, as the distance is shorter and the material encountered more compact; but the length of tunnel required through the ridge south of Cabanas to the outfall, is greater than tunneling the ridge near El Morro, which makes the total cost of an outfall at O'Reilly or Obispo streets more than at La Punta.

METHOD OF COLLECTING THE SEWAGE.

A brief mention has been made of the two systems of sewerage, viz: The combined and separate systems.

As all the sewage from the city will necessarily require pumping, and as some of it will have to be pumped twice, it is important, on account of the cost of maintenance, that the quantity of sewage be reduced to a minimum, which can best be accomplished by adopting the separate system.

Either the combined or separate system will accomplish the object sought; that is, the prompt removal of sewage and foul liquids from all buildings.

It is, however, also imperative that storm water be removed from the streets, so that it will not cause trouble and annoyance to the public, and this fact must be taken into careful consideration in designing a system of sewerage and drainage for Habana.

One serious danger must be avoided, that of the overflow of the sewers. In case the combined system were to be adopted, and overflows occurred during heavy storms, sewage would be deposited on the surface of the streets and courtyards, which might rapidly spread disease. Therefore in the combined system the sewers must be of sufficient size to meet the requirements of the heaviest storms that may occur. It is difficult, and perhaps impossible, to predict what the requirements will be, and to build sewers so large that there will be no possibility of their being surcharged, would be expensive. It is, however, not a difficult matter to estimate with comparative closeness the amount of sewage proper that will have to be provided for and to calculate sizes suitable for the necessities.

The storm drains might overflow some without causing serious harm, as they would overflow only on the surface of the streets, and, furthermore, they would leave behind no worse deposits than entered them from other parts of the street, as they would contain no sewage.

Again, another important matter is that the sewers, whether of the combined or separate system, shall be kept clean and free from deposits. To do this (as is hereafter stated) it will be necessary to flush the system or certain sewers in the system from time to time, particularly during the dry season, and especially with the combined system, where the flow of sewage will be small as compared to the size of the sewer.

It will be much more difficult and will consume much more water to keep a combined system clean during the dry season than it will the separate system. Of course during the rainy season the storm water will flush the sewers, but the amount of water used for flushing the sewers during the year will doubtless be more with the combined than with the separate system, as the extra quantity required with the latter system during the dry season will amount to more than the water used for the separate system during the wet season.

In the combined system, as has been stated, larger sewers are required than in the separate system, and they are usually laid at the same depth.

Inasmuch as in the separate or double system the sewers for sewage only can be much smaller than in the combined system, the storm-water drains, where needed, can be laid nearer the surface of the street; also there will be many streets, or portions of them, where no storm-water drains will be required, as the surface water can be allowed to run off in the gutters for short distances without inconvenience to anyone, thus saving the expense of one of the sewers.

The combined system will require expensive overflow chambers and regulating devices to prevent storm water from entering the interceptors from the district sewers, and it will also require larger interceptors to carry, in addition to the sewage, a certain amount of storm water that will inevitably reach them before the regulators shut off this additional quantity. When all these items are taken into consideration it will be found that the combined system will cost nearly, if not quite, as much as the separate system supplemented by storm drains.

A large item of expense in maintaining the combined system is the extra cost of pumping the storm water that passes through the regulating chambers in light storms. Either the regulating chambers must be so closely regulated that a very small amount of storm water will reach the interceptors (in which case sewage is quite sure to overflow into the harbor at times of storm), or, if ample provision is made to take the maximum flow of sewage, then a large percentage of storm water is likely to reach the interceptors, especially if the storms occur at the time of minimum flow of sewage. The annual cost of pumping the storm water from a combined system of sewerage for Habana if capitalized would amount to more than the difference of cost between building a separate system with whatever storm-water drains are needed and that of building a combined system.

The streets in the old part of the city are extremely narrow, some of them being less than 15 feet in width, which would seem to prohibit the building of two lines of sewers; but this difficulty can be overcome by building the sanitary sewer first, after which the storm-water drain can be built directly over the former in the same trench, and by swinging the ends of the line slightly at street intersections the man-holes can be built without any serious difficulty.

RECOMMENDATIONS.

After a careful review of the entire situation, I am convinced that the separate system of sewerage, supplemented with storm-water drains where needed, is the best system for the city of Habana, and I therefore recommend its adoption; and that the

place of disposal be located at a point about 3,500 feet east of El Morro, or substantially at the same point as that suggested by Mr. McComb in a report recently submitted by him; and that the sewage be discharged into the Gulf 600 feet offshore without any previous treatment.

It is further recommended that the main pumping station be located on the east side of the harbor near El Morro, and that the sewage be concentrated at La Punta and taken across the harbor in submerged masonry pipes to a pump well, from which it will be lifted by the pumps into the main outfall sewer, built partly in tunnel through the ridge and partly in open cut to point of discharge.

It is also recommended that provision be made for eventually taking into the general system all the sewage from the suburban districts, including El Vedado, El Carmelo, Regla, and Casa Blanca, and the plans and estimates presented do so provide.

ELEMENTS OF DESIGN.

(a) *Storm-water drains.*—In designing a system of storm-water drains for Habana it is necessary to consider the storms of greatest intensity and of longest duration.

The storm of greatest intensity of which we have any record was at the rate of 3.07 inches per hour for a duration of ten minutes. Another severe storm is recorded at the rate of 2.75 inches per hour for twenty-three minutes, and another at the rate of 2.10 inches per hour for two and one-half hours; this last storm, being of so much longer duration, would be more likely to cause damage, although not quite so intense as either of the former.

Several severe storms have been recorded, but only three of these have been selected to indicate what may be expected as a maximum to provide against.

If a drainage system were to be designed of sufficient capacity to carry all the storm water continuously, when raining at the rate of 2.10 inches per hour for two and one-half hours, it would be sufficient to remove the storm water when raining at the rate of 3.07 inches per hour for ten minutes, as it would require from eight to ten minutes at the latter rate to fill the drains, and by that time the maximum flow would be diminished. If necessary, the drains could flow under slight pressures, although it is preferred that they do not.

The drains should be so proportioned that they will remove the storm water from the streets during the most severe storms, and any increase beyond this is a needless expenditure of money.

Several formulæ for the run-off have been prepared by engineers from observations of the flow from storm in various localities and under varying conditions. The two principal formulæ are those prepared by Burkli-Ziegler and R. E. McMath, C. E., of St. Louis, Mo., the latter being a modification of the former.

These formulæ are as follows:

$$\text{Burkli-Ziegler } Q = cr \sqrt[4]{A^3} S$$

$$\text{McMath } Q = cr \sqrt[5]{A^4} S$$

Q = the quantity in cubic feet per second that will run off at the lower end of a given area.

c = coefficient depending upon the nature of the area.

r = rainfall in inches per hour.

A = area in acres.

S = slope of the area per 1,000.

The value of c was generally intended to be 0.750 for paved and built-up areas, such as are found in cities of the United States, 0.620 for average city areas, and 0.310 for rural or suburban districts.

For Habana it was thought best to use a larger value for c , especially in the old part of the city, as the area is nearly all built over, and when the streets are paved there will not be much area left that is not well covered with an impervious material.

By analyzing and plotting the two formulæ above referred to, it will be seen that the Burkli-Ziegler formula will give results of more than 100 per cent of the rainfall on small areas of 5 acres or less, which is, of course, inconsistent. The McMath formula gives less results for small areas and a slight increase for larger areas, the line of equality crossing at about 9 acres with a coefficient of 0.875.

I am convinced that provision should be made for removing the storm water from a rainfall of 2½ inches per hour, and that 0.875 should be used for a coefficient with

the McMath formula, on all the area contained in the old part of the city, allowing an average of 10 per 1,000 for the general slope of the ground.

For determining the size of the sewers the well-known Kutter formula was used, with $n=0.014$ for all brick sewers and $n=0.013$ for all pipe sewers. All the sewers and drains in both systems are designed to have velocities when flowing full, or one-half full, of not less than 3 feet per second.

Fortunately the city of Habana is so situated that outlets for storm-water drains can be readily made either into the harbor or into the Gulf. The district areas can be comparatively small, the largest being San Nicolas district, on the south side, comprising 144 acres.

It is not thought necessary to use catch-basins on this system, but inlets should be built at the street corners and such other locations as may be necessary. These inlets are to be built into the curb line on the sidewalk, and should be provided with iron gratings, but no traps will be needed.

Manholes are designed for all street intersections, and at all changes of grade and direction of line.

Generally, the storm drains are to be of circular shape, and are calculated to run full under maximum conditions.

The crowns of the drains are intended to coincide in elevation wherever change of sizes occur.

No system of storm drainage has been designed for the suburban districts, as it does not seem advisable to build drains there at the present time, except to inclose the Matadero, Agua Dulce, and the Maboá creeks, to points above where they are likely to become polluted.

Matadero Creek drains an area of 1,843 acres, as determined from a survey of the engineer's department. There is also a small quantity of water reaching the creek from the Zanja Real through the irrigating ditches, the amount of which is not definitely known at the present time.

The drainage area west of the Infanta and south of the creek is 1,580 acres. The larger portion of this area is flat and under cultivation, while there are other portions quite steep and occupied with buildings. Therefore it is thought best to use an average of 20 to 1,000 for the slope of the area, and a coefficient of 0.450 with the McMath formula to calculate the maximum run-off at the Infanta. For all territory in the old part of the city east of the Infanta and north of the creek the areas and quantities of run-off are made up directly from the several drainage districts in this part of the city.

The total maximum discharge at the lower end of the drain is calculated at 1,169 cubic feet per second, with a rainfall of 2.5 inches per hour, requiring a drain 14 feet in diameter.

Estimates of cost have been made on a circular form of drain, but it may be that the form will have to be made flatter on account of crossing under the highways.

The bridges which span this creek will have to be remodeled to allow of larger waterway, the estimated cost of which is \$25,000.

The other streams above referred to also receive more or less water from the irrigation ditches, in addition to the natural drainage. More information or data is needed than is now collected in regard to these drainage areas and the quantity of water reaching the streams from outside sources before definite plans can be made or inclosing the same.

Two of the drainage districts in the old part of the city, namely, Oquendo on the north, and Arbol Seco on the south, have been designed to take, respectively, 15 and 20 cubic feet per second (in addition to the natural drainage), to allow for water brought down by the irrigation ditches in these vicinities. These quantities are approximate and are subject to change when more data is obtained and when details are prepared for the work.

(b) *Sewerage system.*—This system has been designed upon a basis of 200 people per acre in the old part of the city, extending from the harbor on the east to Calzada de la Infanta on the west and north of Matadero Creek, and 80 people per acre for all of the suburban districts.

An allowance of 150 gallons of water per capita for twenty-four hours, with 50 per cent additional, is made for the maximum flow in the sewers, or what would be equivalent to 225 gallons per capita. An allowance of 150 gallons per acre per day is also made for ground water reaching the sewers.

The district sewers are calculated to carry the maximum quantity (225 gallons per capita per day) when flowing one-half full, leaving one-half the capacity of the sewer for emergencies. The marginal sewers are calculated to flow six-tenths full, for the reason that the maximum flow from all the various districts will not reach the marginals at the same time; therefore the margin or coefficient of safety for size need not be quite so large as would otherwise be required. There is one exception, however, to this rule, and that is the north side marginal sewer from La Punta to San

Lazaro, which is designed to take (in addition to the sewage from the northern slope) the sewage from the districts of El Vedado and El Carmelo. It was thought best to calculate this sewer as flowing full, assuming that the maximum quantity from all the districts could reach the marginal at the same time; but the districts are so remote it would be impossible for these conditions to occur, hence an exception has been made in this case. For the same reason the outfall sewer from El Morro to the outlet on the Gulf is also calculated to flow full at the maximum rate from the entire city.

The future population provided for by the entire system is, approximately, 600,000. The sewage, together with the ground water, amounts to 92,000,000 gallons per day, while the maximum flow is at the rate of 138,000,000 gallons per day. Therefore, as the outfall sewer is designed to carry the maximum rate when flowing full, it may be considered of sufficient capacity.

With the above quantities the maximum flow amounts to 0.070 cubic feet per second per acre for the old part of the city, and 0.028 cubic feet per second per acre for the suburban districts.

GENERAL DESIGN.

The general plan for collecting the sewage is somewhat similar to that outlined in the McComb report. This design, however, contemplates eventually taking the sewage from El Vedado, El Carmelo, Regla, and Casa Blanca, which districts were not included in the report referred to.

A marginal sewer will extend from a collecting well at La Punta to serve the east and south sections of the city, following through Cuba, Obispo, Oficios, Churrucá, San Pedro, Oficios, Paula, San Ignacio, and Desamparados streets to Egido street. On the north side of the city a marginal sewer will extend from the junction of the former sewer near La Punta, following through Carcel, Consulado, Refugio, Industria, Colon, Aguila, Trocadero, Ancha del Norte, and San Lazaro streets to Marina, where it divides, one branch passing up San Lazaro and the other passing out Marina, to take the sewage which will eventually come from the western suburbs of El Vedado and Carmelo.

In the southern section of the city near Matadero Creek is a low district, the sewage from which will have to be lifted into the gravity system, through which it will then flow to El Morro pumping station, where it will again require pumping. This district comprises about 290 acres in the old part of the city and 460 acres south of Matadero Creek.

Estimates were made for taking the sewage from this low district through a low level tunnel under or near Hospital street to avoid pumping. It was found that if the sewage was to be discharged at Almendares or Punta Brava this plan could be made practicable. With the main pumping station located at San Lazaro, near the northern end of the proposed low level tunnel, and by building a pump well there, at a lower elevation than would be required at La Punta, a grade could be secured that would be sufficient to take the sewage from the low district without pumping. But the interest on the first cost of the low level tunnel, and on the extra cost of the out-fall sewer for the Almendares project, would exceed the annual cost of pumping from the low district through a tunnel built at a higher elevation.

The plan proposed is to collect all the sewage from the low district at a pumping station on Calzada de Vives, nearly opposite Carmen street, and pump it through a force main laid in Carmen street to Campanario, where the high level marginal sewer will commence, thence passing through Carmen, Belascoain, Benjumeda, Delicias, Desague, Santa Rosalia, Penalver, Aramburu, and Sitios to Hospital street, from which point the sewer will be in tunnel to Hamal street.

The southern marginal sewer for the low district in Cerro and Jesus del Monte is designed to be built through private property east of the Western Railway station and tracks as far as Concha street. If a right of way can be easily secured along this line it would be well to do so, as the cost of building the sewer here would be much less than if built in Cristina street, on account of the extra heavy cutting in the latter street.

The sewer built in tunnel through the ridge under Hospital street above referred to will serve to take nearly all the sewage by gravity from Jesus del Monte and Cerro and a section on the south side of the city to the collecting well at La Punta.

To collect the sewage from the higher portions of El Vedado a high-level sewer is designed to extend through Marina street, following the line of the dummy railroad to G street; thence in Eleventh street to Eighth street, intercepting all the sewage coming from the territory lying to the south and west of the sewer. This marginal sewer can be extended farther west as required, following the contour of the ground or as future developments may dictate, and will discharge by gravity into the marginal sewer in San Lazaro.

To collect the sewage from the eastern and western portions of El Vedado and El Carmelo a series of lifts are necessary, on account of the long, level coast line from which the sewage must be collected. A small pumping station can be erected at the corner of Ninth and L streets, equipped with a steam pumping plant and electric dynamos with which to operate the sublifts at the corner of Fifth and B streets and Seventh and Sixteenth streets. These sublifts can be operated automatically by electric pumps from the station, corner of Ninth and L streets, or by compressed air, using the Shone system. The lifts at these stations average about $9\frac{1}{2}$ feet each, while the lift at the main station is $16\frac{1}{2}$ feet.

Considerable study has been given to the disposal of sewage from Regla and Casa Blanca, and, while the data at hand is not sufficient to design a complete system for either of these suburbs, there is sufficient data to consider the question in a general way.

It is believed that all the sewage from Regla can be collected at the northerly point by marginal sewers built along the shore fronts, and from there taken across the harbor to Casa Blanca in a submerged iron pipe. The water in the harbor at this place is about 30 feet deep in the channel, and the bottom is of a soft and muddy nature, as indicated by the charts. It would not be very expensive to dredge a channel across the harbor to the Casa Blanca side and lay an iron pipe below the bottom, where it will be out of danger from navigation.

At Casa Blanca a pumping station could be built near the western end of the town, into which the sewage from Regla and Casa Blanca could be collected and pumped, either over the ridge into the main outfall sewer east of El Morro or by laying a force main along the harbor front, discharged into the main outfall at the entrance to the tunnel. It is recently reported that a highway is now being built along the harbor front on the east side, from Casa Blanca to El Morro. If this is the fact it might be more economical to adopt the latter project.

The general system of sewerage is designed to eventually have four pumping plants and two sublifts, as follows: The main pumping station at El Morro; the south side pumping station at Calzada de Vives; the Vedado pumping station with two sublifts; the Casa Blanca pumping station.

EL MORRO PUMPING STATION.

At this station it is intended to pump all the sewage from the city and suburbs, with the exception of Regla and Casa Blanca, the two latter places being treated separately.

The entire quantity of sewage that will reach El Morro station when the population shall have reached 600,000 is estimated at an average of 93,000,000 gallons per day, with a maximum rate 50 per cent greater, or at the rate of 138,000,000 gallons per day during a portion of the twenty-four hours.

The total lift at El Morro station, including friction head in the siphons and force mains, is 23.30 feet, requiring 271 horsepower while pumping the average quantity per day.

It will require four 36,000,000-gallon pumps, with 600-horsepower boiler capacity to do the work and at the same time have a sufficient reserve. These pumps are intended to be of the triple-expansion high-duty type, to economize in the use of fuel.

The station should be provided with filth hoists, screens, and pump wells, the details of which should be carefully worked out.

The plan contemplates bringing the sewage across the harbor in two inverted siphons 5 feet in diameter, to be made of 3 rings of brick masonry inclosed in steel riveted pipes. These siphons to be built in sections, and each about 20 feet in length, with cast-iron flanges at each end provided with bulkheads and floated to the proper location and sunk into the trenches to be provided for them. The ends of the sections are to be connected by bolting together the iron flanges, and the bulkheads removed with the aid of a diver, in a similar manner to those siphons laid across Shirley Gut for the Metropolitan sewerage system near Boston, Mass.

The shore end of the siphons will be built in tunnel 7 feet in diameter for a distance of about 200 feet. From the ends of these tunnels on either side of the harbor a channel should be cut in the rock or other material encountered, to a width sufficient for two pipes, and of sufficient depth to allow the pipes to be entirely covered. This method of construction forms permanent conduits, which, when completed, will last for all time and will be no obstruction to navigation.

For present purposes it will not be necessary to build more than one of these siphons or to install more than two pumping engines with 300-horsepower boilers.

The force mains will be 5 feet in diameter, of riveted steel, and approximately 100 feet long each. Only one of these will be needed for present purposes.

The outfall sewer from El Morro to the point of discharge is to be 7 feet in diameter, built of concrete, with brick invert, partly in tunnel and partly in open cut, the tunnel section being about 1,480 feet, and the open cut 2,250 feet.

The outfall sewer is to discharge into a well built about 100 feet back from the shore line, from which two cast-iron pipes will be laid in an open-cut trench out into the gulf 700 feet from the well. One pipe is all that will be required for the present.

SOUTH SIDE PUMPING STATION.

The proposed location for this station is on Calzada de Vives, nearly opposite Carmen street, and is intended to receive all the sewage from the low district and pump it into the high-level system at the corner of Carmen and Campanario streets.

The quantity of sewage that will ultimately reach this station is estimated at 14,250,000 gallons per day, with a maximum rate of 21,375,000 gallons per day.

The lift at this station is 21 feet, requiring 78 horsepower to raise the sewage when flowing at its maximum rate, or an average of 52 horsepower.

Three 8,000,000-gallon pumps, with 225-horsepower boilers, are proposed for this station, which will give an ample reserve.

It is suggested that direct-acting plunger pumps, of compound condensing type, should be used for this station, as they are more economical than pumps of centrifugal type. These pumps ought to be such as will give a duty of at least 80,000,000 foot-pounds. Two pumps and two boilers would only be required for the present.

The force main, 36 inches in diameter, is intended to answer for all time, and is shown on the plan as laid in Carmen street; but, as there is a sewer and storm drain planned for this street, it may be thought advisable to lay the force main in Rastro and Campanario streets instead.

VEDADO PUMPING STATION.

As has been stated, the long, low coast line of El Vedado and El Carmelo renders it impracticable to bring the sewage by gravity from the lowest sections of these suburbs into the marginal sewer in San Lazaro, therefore it is thought advisable to plan for a pumping station at the corner of L and Fifth streets. It will not, of course, be advisable to allow sewage to discharge permanently into the gulf near the coast, as more or less of it will be deposited on the shore by the wind and tides, thereby causing a nuisance, as already stated.

The average quantity of sewage for the Vedado station is estimated at 5,350,000 gallons per day, or a maximum rate of 2,025,000 gallons. The total lift, including friction head in the force main, amounts to 16½ feet, requiring an average of 15 horsepower.

Two 6,000,000-gallon pumps, and two 12-horsepower electric generators, operating the two automatic electric lifts at the corners of Fifth and B streets and Seventh and Sixteenth streets, with two 60-horsepower boilers, will be required at this station.

The subliffs should also be in duplicate. At the first substation, Fifth and B streets, each subliff should have a capacity of 2,500,000 gallons per day, the lift being about 9.15 feet, and requiring 5 horsepower.

At the second substation (corner of Seventh and Sixteenth streets) each subliff should be capable of raising 800,000 gallons of sewage per day to a height of 10.30 feet, requiring about 3 horsepower.

These substations should be so arranged that they can work automatically. They could, if thought best, be worked by compressed air, using the Shone injector, in which case the electric generators would be replaced by air compressors.

CASA BLANCA PUMPING STATION.

To provide for Regla and Casa Blanca it is suggested that a pumping station be built in Casa Blanca at or near the Tricornia docks, and the sewage pumped from both districts, as before stated, either over the ridge to the main outfall, or through a force main in Casa Blanca near the harbor front to the outfall sewer at El Morro.

The sewage from Regla can be brought across the harbor in a 16-inch cast-iron pipe laid from the northerly point to the pumping station in Casa Blanca.

It is estimated that the average quantity of sewage from Regla and Casa Blanca will be 4,800,000 gallons per day with a maximum rate of 7,200,000 gallons per day. The lift at this station is not definitely known, but if pumped over the ridge it will be approximately 60 feet; and if the force main can be laid in the proposed highway to El Morro, the lift will not exceed 25 or 30 feet, including friction in the mains. Two 4,000,000-gallon pumps and two 100-horsepower boilers are estimated

for this plant, but if the lower lift should be adopted the boiler power could be reduced one-half.

It is proposed to use vitrified pipe for all sewers and storm drains from 8 to 20 inches in diameter, inclusive; sizes ranging from 24 to 30 inches in diameter will be made of single ring brick; larger sizes will be made of concrete, with a single course of vitrified brick in the invert.

No sewer smaller than 8 inches in diameter should be laid in the sewerage system, and no drain less than 12 inches in diameter should be laid in the drainage system.

The house connections should be 6-inch pipe.

It is designed that the center of the sanitary sewers should be laid generally about 6 feet below the grade of the street, but there are cases where it is necessary to go deeper in order to obtain sufficient grades to give the proper velocities to the sewage.

The crowns of the storm drains need not be laid more than 3 feet below the grade of the street, except to obtain proper grades.

Manholes should be constructed at all changes of grades and lines; also at all street intersections.

The manholes on the separate system should be provided with tight covers, and the ventilation of the sewers may be made through the house connections by carrying a standpipe to the roof on the outside of the buildings, omitting the running traps; but all house fixtures should be trapped and properly ventilated.

It is essential that the sewerage system should be kept clear of deposits, and the best way to do this is to provide flush tanks at the upper ends of all the principal lines of sewers.

Automatic flush tanks holding from 30 to 50 gallons are often used, which are connected with the city water supply and are intended to fill and discharge at stated intervals; but experience shows that unless great care and attention is given them in many cases they either fail to discharge at all, or that they discharge far too frequently, thus wasting water, and sometimes in large quantities. It will probably be found that the sewers will be kept cleaner, and that with less water, by connecting the flush tank with the city supply and employing a man to fill and discharge them as often as each particular sewer may require. Some sewers no doubt will need to be flushed daily, some semiweekly, and others less often.

An intelligent man in charge of the maintenance will soon become familiar with the needs of each street, and will get better results from a street-to-street visit, and at a less cost, than with flush tanks filling and discharging automatically.

ESTIMATES OF COST.

The estimated cost of the entire works, including all that is required for the future, as shown on the accompanying plans, is as follows:

| | |
|----------------------------|-------------|
| Drainage system..... | \$574, 090 |
| Matadero Creek system..... | 299, 805 |
| Sewerage system..... | 3, 108, 897 |
| Total..... | 3, 982, 792 |

The estimated value of the works which need not be built for the present amounts to \$709,081.45, as will be seen by the detailed estimates, leaving \$3,273,710.55 as the cost of building a system ample for the present time.

There are also some localities where sewers and storm drains have been planned but need not be built for some time (unless the streets are to be paved soon), although they are included in the estimates of cost.

CONCLUSIONS.

In concluding this report allow me to say that there are many details that will require careful study in order to accomplish the best results. Many houses are so built that the first floors are far below the grade of the streets. In these cases some difficulty may be met in designing a system for the fixtures as well as for the drainage of the court yards and roofs, and it would be far preferable if these floors could be raised above the level of the streets.

Many business blocks and houses are connected with the present drains, and in order to separate the sewage from the storm water it may be necessary in some cases to reconstruct their drainage system, thereby entailing some expense to the owners of the property, but this ought not to stand in the way of securing the best modern methods of sanitation.

The estimates of cost do not include the cost of house connections from the sewers to the buildings, as the expense of these is usually borne by the abutters. These

connections should, however, be put in at the time the sewers are built, so as to save again breaking up the pavements, more especially in streets that are soon to be paved.

It is estimated that it will cost about \$200,000 to lay the house connections for the portion of the system recommended to be built at present.

When the system is completed, all the houses on the line of sewers should be connected in the best possible manner, and all cesspools and privies thoroughly disinfected and filled up. Modern water-closets and other fixtures of the most simple types should be installed, particularly among the more ignorant and poorer classes of people, until they become familiar with the use and care of these improvements.

In designing the system of sewerage and drainage many trial plans had to be prepared, and estimates of cost made, in order to determine upon the best project. The trial plans and estimates made were more or less incomplete, as the nature of the case required.

I desire to acknowledge my indebtedness to General Ludlow and Colonel Black for the facilities which they placed at my command to enable me to make my investigations, and to express my appreciation of the assistance given me by the city engineer, P. D. Cunningham, C. E., and Capt. A. W. Cooke, and other gentlemen connected with the harbor, water, sewer, and street departments.

I also wish to acknowledge the value of the services of R. H. Keays, C. E., whose faithful, diligent labors have been of great aid to me in the prosecution of the work.

Mention should also be made of the value of the report submitted to you, and data collected by D. E. McComb, C. E., of Washington, D. C.

Respectfully,

SAMUEL M. GRAY,
Consulting Engineer.

P. D. CUNNINGHAM, C. E.,
Chief Engineer, Habana, Cuba.

Appendix.

DRAINAGE SYSTEM.—DETAILED ESTIMATES.

Mercaderes system:

| | |
|--------------------------------------|----------|
| 12-inch drain, 200 feet, at \$0.60 | \$120.00 |
| 18-inch drain, 2,300 feet, at \$1.25 | 2,875.00 |
| 20-inch drain, 1,340 feet, at \$1.55 | 2,077.00 |
| 24-inch drain, 3,560 feet, at \$2.10 | 7,476.00 |
| 28-inch drain, 320 feet, at \$2.40 | 768.00 |
| 32-inch drain, 1,170 feet, at \$4 | 4,680.00 |
| 36-inch drain, 740 feet, at \$4.40 | 3,256.00 |
| 40-inch drain, 540 feet, at \$4.80 | 2,592.00 |
| 50-inch drain, 630 feet, at \$5.80 | 3,654.00 |
| 58-inch drain, 520 feet, at \$6.60 | 3,432.00 |
| 62-inch drain, 410 feet, at \$9.20 | 3,772.00 |
| 64-inch drain, 330 feet, at \$9.50 | 3,135.00 |
| Manholes, 51, at \$40 | 2,040.00 |
| Inlets, 196, at \$12 | 2,352.00 |

42,229.00
Add 10 per cent for contingencies..... 4,222.90

Total 46,451.90

Santa Clara system:

| | |
|------------------------------------|--------|
| 18-inch drain, 360 feet, at \$1.25 | 450.00 |
| Manholes, 2, at \$40 | 80.00 |
| Inlets, 8, at \$12 | 96.00 |

626.00
Add 10 per cent for contingencies..... 62.60

Total 688.60

Sol system:

| | |
|------------------------------------|--------|
| 15-inch drain, 310 feet, at \$0.90 | 279.00 |
| 18-inch drain, 310 feet, at \$1.25 | 387.50 |
| 24-inch drain, 130 feet, at \$2.10 | 273.00 |
| Manholes, 3, at \$40 | 120.00 |
| Inlets, 12, at \$12 | 144.00 |

1,203.50
Add 10 per cent for contingencies..... 120.35

Total 1,323.85

Lamparilla system:

| | |
|--------------------------------------|----------|
| 12-inch drain, 1,130 feet, at \$0.60 | 678.00 |
| 15-inch drain, 2,030 feet, at \$0.90 | 1,827.00 |
| 18-inch drain, 1,420 feet, at \$1.25 | 1,775.00 |
| 20-inch drain, 1,540 feet, at \$1.55 | 2,387.00 |
| 24-inch drain, 1,690 feet, at \$2.10 | 3,549.00 |
| 26-inch drain, 1,500 feet, at \$2.20 | 3,300.00 |
| 28-inch drain, 620 feet, at \$2.40 | 1,488.00 |
| 30-inch drain, 850 feet, at \$2.50 | 2,125.00 |
| 34-inch drain, 1,250 feet, at \$4.20 | 5,250.00 |
| 36-inch drain, 260 feet, at \$4.40 | 1,144.00 |
| 38-inch drain, 520 feet, at \$4.60 | 2,392.00 |
| 42-inch drain, 330 feet, at \$5 | 1,650.00 |
| 44-inch drain, 520 feet, at \$5.10 | 2,652.00 |
| 56-inch drain, 580 feet, at \$6.40 | 3,712.00 |
| 64-inch drain, 850 feet, at \$9.50 | 8,075.00 |
| 66-inch drain, 140 feet, at \$9.60 | 1,344.00 |
| Manholes, 62, at \$40 | 2,480.00 |
| Inlets, 248, at \$12 | 2,976.00 |

48,804.00
Add 10 per cent for contingencies..... 4,880.40

Total 53,684.40

Belascoain system (south):

| | |
|------------------------------------|----------|
| 18-inch drain, 260 feet, at \$1.25 | 325.00 |
| 24-inch drain, 360 feet, at \$2.10 | 756.00 |
| 26-inch drain, 450 feet, at \$2.20 | 990.00 |
| 32-inch drain, 390 feet, at \$4 | 1,560.00 |
| 42-inch drain, 140 feet, at \$5 | 700.00 |
| Manholes, 10, at \$40 | 400.00 |
| Inlets, 36, at \$12 | 432.00 |

5,163.00
Add 10 per cent for contingencies..... 516.30

Total 5,679.30

Industria system:

| | |
|--------------------------------------|----------|
| 12-inch drain, 510 feet, at \$0.60 | 306.00 |
| 15-inch drain, 570 feet, at \$0.90 | 513.00 |
| 18-inch drain, 1,820 feet, at \$1.25 | 2,275.00 |

Appendix—Continued.

DRAINAGE SYSTEM.—DETAILED ESTIMATES—continued.

Industria system—Continued:

| | |
|-------------------------------------------|----------|
| 20-inch drain, 480 feet, at \$1.55..... | \$744.00 |
| 24-inch drain, 590 feet, at \$2.10..... | 1,239.00 |
| 28-inch drain, 1,050 feet, at \$2.40..... | 2,520.00 |
| 38-inch drain, 380 feet, at \$4.60..... | 1,748.00 |
| 50-inch drain, 310 feet, at \$5.80..... | 1,798.00 |
| 54-inch drain, 240 feet, at \$6.20..... | 1,488.00 |
| 56-inch drain, 370 feet, at \$6.40..... | 2,368.00 |
| 60-inch drain, 430 feet, at \$8.90..... | 3,827.00 |
| Manholes, 28, at \$40..... | 1,120.00 |
| Inlets, 192, at \$12..... | 2,304.00 |

22,250.00

Add 10 per cent for contingencies..... 2,225.00

Total..... 24,475.00

Aquilla system:

| | |
|-------------------------------------------|----------|
| 12-inch drain, 1,360 feet, at \$0.60..... | 816.00 |
| 15-inch drain, 900 feet, at \$0.90..... | 810.00 |
| 18-inch drain, 2,060 feet, at \$1.25..... | 2,575.00 |
| 20-inch drain, 2,410 feet, at \$1.55..... | 3,735.50 |
| 24-inch drain, 1,920 feet, at \$2.10..... | 4,032.00 |
| 26-inch drain, 1,000 feet, at \$2.20..... | 2,200.00 |
| 28-inch drain, 330 feet, at \$2.40..... | 792.00 |
| 32-inch drain, 240 feet, at \$1..... | 960.00 |
| 34-inch drain, 720 feet, at \$4.20..... | 3,024.00 |
| 36-inch drain, 370 feet, at \$4.40..... | 1,628.00 |
| 38-inch drain, 260 feet, at \$4.60..... | 1,196.00 |
| 44-inch drain, 300 feet, at \$5.10..... | 1,530.00 |
| 46-inch drain, 260 feet, at \$5.40..... | 1,404.00 |
| 50-inch drain, 200 feet, at \$5.80..... | 1,160.00 |
| 56-inch drain, 250 feet, at \$6.40..... | 1,600.00 |
| 62-inch drain, 260 feet, at \$9.20..... | 2,392.00 |
| 66-inch drain, 630 feet, at \$9.60..... | 6,048.00 |
| 68-inch drain, 320 feet, at \$10..... | 3,200.00 |
| 78-inch drain, 560 feet, at \$11.20..... | 6,272.00 |
| Manholes, 54, at \$40..... | 2,160.00 |
| Inlets, 216, at \$12..... | 2,592.00 |

50,126.40

Add 10 per cent for contingencies..... 5,012.65

Total..... 55,139.15

Factoria system:

| | |
|-------------------------------------------|----------|
| 12-inch drain, 1,420 feet, at \$0.60..... | 852.00 |
| 15-inch drain, 1,310 feet, at \$0.90..... | 1,179.00 |
| 18-inch drain, 770 feet, at \$1.25..... | 962.50 |
| 20-inch drain, 420 feet, at \$1.55..... | 651.00 |
| 24-inch drain, 1,400 feet, at \$2.10..... | 2,940.00 |
| 28-inch drain, 490 feet, at \$2.40..... | 1,176.00 |
| 30-inch drain, 1,290 feet, at \$2.50..... | 3,225.00 |
| 50-inch drain, 310 feet, at \$5.80..... | 1,798.00 |
| 52-inch drain, 210 feet, at \$6..... | 1,260.00 |
| Manholes, 35, at \$40..... | 1,400.00 |
| Inlets, 136, at \$12..... | 1,632.00 |

17,075.50

Add 10 per cent for contingencies..... 1,707.55

Total..... 18,783.05

Chacon system:

| | |
|-----------------------------------------|----------|
| 18-inch drain, 500 feet, at \$1.25..... | 625.00 |
| 24-inch drain, 970 feet, at \$2.10..... | 2,037.00 |
| 32-inch drain, 430 feet, at \$4..... | 1,720.00 |
| Manholes, 8, at \$40..... | 320.00 |
| Inlets, 32, at \$12..... | 384.00 |

5,086.00

Add 10 per cent for contingencies..... 508.60

Total..... 5,594.60

Arbol Seco system:

| | |
|-------------------------------------------|----------|
| 12-inch drain, 2,220 feet, at \$0.60..... | 1,332.00 |
| 15-inch drain, 3,020 feet, at \$0.90..... | 2,718.00 |
| 18-inch drain, 310 feet, at \$1.25..... | 387.50 |
| 20-inch drain, 320 feet, at \$1.55..... | 341.00 |
| 24-inch drain, 300 feet, at \$2.10..... | 630.00 |
| 28-inch drain, 130 feet, at \$2.40..... | 312.00 |
| 30-inch drain, 600 feet, at \$2.50..... | 1,500.00 |
| 32-inch drain, 1,280 feet, at \$4..... | 5,120.00 |
| 34-inch drain, 830 feet, at \$4.20..... | 3,486.00 |

Arbol Seco system—Continued:

| | |
|------------------------------------------|------------|
| 42-inch drain, 590 feet, at \$5..... | \$2,950.00 |
| 44-inch drain, 590 feet, at \$5.10..... | 3,009.00 |
| 50-inch drain, 590 feet, at \$5.80..... | 2,842.00 |
| 68-inch drain, 260 feet, at \$10..... | 2,600.00 |
| 70-inch drain, 590 feet, at \$10.20..... | 6,018.00 |
| 82-inch drain, 580 feet, at \$11.70..... | 6,786.00 |
| 84-inch drain, 430 feet, at \$12..... | 5,160.00 |
| Manholes, 39, at \$40..... | 1,560.00 |
| Inlets, 148, at \$12..... | 1,776.00 |

48,527.50

Add 10 per cent for contingencies..... 4,852.75

Total..... 53,380.25

Acosta system:

| | |
|-------------------------------------------|----------|
| 12-inch drain, 1,730 feet, at \$0.60..... | 1,038.00 |
| 15-inch drain, 410 feet, at \$0.90..... | 369.00 |
| 18-inch drain, 700 feet, at \$1.25..... | 875.00 |
| 24-inch drain, 1,480 feet, at \$2.10..... | 3,108.00 |
| 26-inch drain, 300 feet, at \$2.20..... | 660.00 |
| 30-inch drain, 450 feet, at \$2.50..... | 1,125.00 |
| 36-inch drain, 300 feet, at \$4.40..... | 1,320.00 |
| 38-inch drain, 160 feet, at \$4.60..... | 736.00 |
| 42-inch drain, 1,270 feet, at \$5..... | 6,350.00 |
| 44-inch drain, 180 feet, at \$5.10..... | 918.00 |
| Manholes, 29, at \$40..... | 1,160.00 |
| Inlets, 116, at \$12..... | 1,392.00 |

19,051.00

Add 10 per cent for contingencies..... 1,905.10

Total..... 20,956.10

Peña Pobre system:

| | |
|-----------------------------------------|--------|
| 20-inch drain, 410 feet, at \$1.55..... | 635.50 |
| Manholes, 3, at \$40..... | 120.00 |
| Inlets, 12, at \$12..... | 144.00 |

899.50

Add 10 per cent for contingencies..... 89.95

Total..... 989.45

San Nicolas system (south):

| | |
|-------------------------------------------|----------|
| 12-inch drain, 1,140 feet, at \$0.60..... | 684.00 |
| 15-inch drain, 2,110 feet, at \$0.90..... | 1,899.00 |
| 18-inch drain, 2,400 feet, at \$1.25..... | 3,000.00 |
| 20-inch drain, 3,180 feet, at \$1.55..... | 4,929.00 |
| 24-inch drain, 2,430 feet, at \$2.10..... | 5,103.00 |
| 26-inch drain, 1,150 feet, at \$2.20..... | 2,530.00 |
| 28-inch drain, 830 feet, at \$2.40..... | 1,992.00 |
| 32-inch drain, 1,050 feet, at \$4..... | 4,200.00 |
| 36-inch drain, 240 feet, at \$4.40..... | 1,056.00 |
| 38-inch drain, 1,880 feet, at \$4.60..... | 8,648.00 |
| 58-inch drain, 430 feet, at \$6.60..... | 2,838.00 |
| Manholes, 76, at \$40..... | 3,040.00 |
| Inlets, 318, at \$12..... | 3,816.00 |

43,735.00

Add 10 per cent for contingencies..... 4,373.50

Total..... 48,108.50

Cuba system:

| | |
|-------------------------------------------|----------|
| 12-inch drain, 310 feet, at \$0.60..... | 186.00 |
| 15-inch drain, 260 feet, at \$0.90..... | 234.00 |
| 18-inch drain, 430 feet, at \$1.25..... | 537.50 |
| 20-inch drain, 1,490 feet, at \$1.55..... | 2,309.50 |
| 28-inch drain, 570 feet, at \$2.40..... | 1,368.00 |
| Manholes, 14, at \$40..... | 560.00 |
| Inlets, 60, at \$12..... | 720.00 |

5,915.00

Add 10 per cent for contingencies..... 591.50

Total..... 6,506.50

Gervasio system:

| | |
|-------------------------------------------|----------|
| 12-inch drain, 450 feet, at \$0.60..... | 270.00 |
| 15-inch drain, 540 feet, at \$0.90..... | 486.00 |
| 18-inch drain, 2,140 feet, at \$1.25..... | 2,675.00 |
| 20-inch drain, 2,170 feet, at \$1.55..... | 3,363.50 |
| 24-inch drain, 1,690 feet, at \$2.10..... | 3,549.00 |
| 26-inch drain, 490 feet, at \$2.20..... | 1,078.00 |

Appendix—Continued.

DRAINAGE SYSTEM.—DETAILED ESTIMATES—continued.

Gervasio system—Continued:

| | |
|------------------------------------------|------------|
| 28-inch drain, 730 feet, at \$2.40 | \$1,752.00 |
| 30-inch drain, 730 feet, at \$2.50 | 1,825.00 |
| 34-inch drain, 520 feet, at \$4.20 | 2,184.00 |
| 36-inch drain, 540 feet, at \$4.40 | 2,376.00 |
| 40-inch drain, 530 feet, at \$4.80 | 2,544.00 |
| 42-inch drain, 240 feet, at \$5. | 1,200.00 |
| 44-inch drain, 610 feet, at \$5.10 | 3,111.00 |
| 48-inch drain, 370 feet, at \$5.60 | 2,072.00 |
| Manholes, 46, at \$40 | 1,840.00 |
| Inlets, 188, at \$12 | 2,256.00 |

| | |
|-----------------------------------------|-----------|
| | 32,581.50 |
| Add 10 per cent for contingencies | 3,258.15 |

| | |
|-------------|-----------|
| Total | 35,839.65 |
|-------------|-----------|

Pilar system:

| | |
|------------------------------------------|----------|
| 34-inch drain, 600 feet, at \$4.20 | 2,520.00 |
| Manholes, 3, at \$40 | 120.00 |
| Inlets, 12, at \$12 | 144.00 |

| | |
|-----------------------------------------|----------|
| | 2,784.00 |
| Add 10 per cent for contingencies | 278.40 |

| | |
|-------------|----------|
| Total | 3,062.40 |
|-------------|----------|

Oquendo system (north):

| | |
|--------------------------------------------|----------|
| 12-inch drain, 980 feet, at \$0.60 | 588.00 |
| 15-inch drain, 1,550 feet, at \$0.90 | 1,395.00 |
| 18-inch drain, 2,590 feet, at \$1.25 | 3,237.50 |
| 20-inch drain, 1,410 feet, at \$1.55 | 2,185.50 |
| 24-inch drain, 780 feet, at \$2.10 | 1,638.00 |
| 26-inch drain, 260 feet, at \$2.20 | 572.00 |
| 28-inch drain, 1,140 feet, at \$2.40 | 2,736.00 |
| 30-inch drain, 1,100 feet, at \$2.50 | 2,750.00 |
| 32-inch drain, 520 feet, at \$4. | 2,080.00 |
| 44-inch drain, 1,030 feet, at \$5.10 | 5,253.00 |
| 48-inch drain, 420 feet, at \$5.60 | 2,352.00 |
| 54-inch drain, 360 feet, at \$6.20 | 3,232.00 |
| 58-inch drain, 60 feet, at \$6.60 | 396.00 |
| 60-inch drain, 230 feet, at \$8.90 | 2,047.00 |
| Manholes, 48, at \$40 | 1,920.00 |
| Inlets, 204, at \$12 | 2,448.00 |

| | |
|-----------------------------------------|-----------|
| | 33,830.00 |
| Add 10 per cent for contingencies | 3,383.00 |

| | |
|-------------|-----------|
| Total | 37,213.00 |
|-------------|-----------|

Principe system:

| | |
|------------------------------------------|----------|
| 12-inch drain, 400 feet, at \$0.60 | 240.00 |
| 15-inch drain, 750 feet, at \$0.90 | 675.00 |
| 18-inch drain, 490 feet, at \$1.25 | 612.50 |
| 20-inch drain, 250 feet, at \$1.55 | 387.50 |
| 24-inch drain, 470 feet, at \$2.10 | 987.00 |
| 30-inch drain, 400 feet, at \$2.50 | 1,000.00 |
| 36-inch drain, 710 feet, at \$4.40 | 3,124.00 |
| Manholes, 13, at \$40 | 520.00 |
| Inlets, 56, at \$12 | 672.00 |

| | |
|-----------------------------------------|----------|
| | 8,218.00 |
| Add 10 per cent for contingencies | 821.80 |

| | |
|-------------|----------|
| Total | 9,039.80 |
|-------------|----------|

Oquendo system (south):

| | |
|--------------------------------------------|----------|
| 12-inch drain, 900 feet, at \$0.60 | 540.00 |
| 15-inch drain, 280 feet, at \$0.90 | 252.00 |
| 18-inch drain, 1,480 feet, at \$1.25 | 1,850.00 |
| 24-inch drain, 1,170 feet, at \$2.10 | 2,457.00 |
| 26-inch drain, 270 feet, at \$2.20 | 594.00 |
| 28-inch drain, 600 feet, at \$2.40 | 1,440.00 |
| 34-inch drain, 350 feet, at \$4.20 | 1,470.00 |
| 50-inch drain, 300 feet, at \$5.80 | 1,740.00 |
| 58-inch drain, 1,050 feet, at \$6.60 | 6,930.00 |
| Manholes, 22, at \$40 | 880.00 |
| Inlets, 96, at \$12 | 1,152.00 |

| | |
|-----------------------------------------|-----------|
| | 19,305.00 |
| Add 10 per cent for contingencies | 1,930.50 |

| | |
|-------------|-----------|
| Total | 21,235.50 |
|-------------|-----------|

Luz system:

| | |
|--------------------------------------------|----------|
| 12-inch drain, 380 feet, at \$0.60 | \$228.00 |
| 15-inch drain, 410 feet, at \$0.90 | 369.00 |
| 20-inch drain, 390 feet, at \$1.55 | 604.50 |
| 30-inch drain, 700 feet, at \$2.50 | 1,750.00 |
| 36-inch drain, 1,020 feet, at \$4.40 | 4,480.00 |
| 40-inch drain, 600 feet, at \$4.80 | 2,880.00 |
| Manholes, 13, at \$40 | 520.00 |
| Inlets, 52, at \$12 | 624.00 |

| | |
|-----------------------------------------|-----------|
| | 11,455.50 |
| Add 10 per cent for contingencies | 1,145.55 |

| | |
|-------------|-----------|
| Total | 12,601.05 |
|-------------|-----------|

Compostela system:

| | |
|--------------------------------------------|----------|
| 12-inch drain, 210 feet, at \$0.60 | 126.00 |
| 15-inch drain, 1,020 feet, at \$0.90 | 918.00 |
| 18-inch drain, 200 feet, at \$1.25 | 250.00 |
| 20-inch drain, 160 feet, at \$1.55 | 248.00 |
| 32-inch drain, 1,000 feet, at \$4 | 4,000.00 |
| Manholes, 11, at \$40 | 440.00 |
| Inlets, 48, at \$12 | 576.00 |

| | |
|-----------------------------------------|----------|
| | 6,558.00 |
| Add 10 per cent for contingencies | 655.80 |

| | |
|-------------|----------|
| Total | 7,213.80 |
|-------------|----------|

Lealtad system:

| | |
|--------------------------------------------|----------|
| 15-inch drain, 740 feet, at \$0.90 | 666.00 |
| 18-inch drain, 260 feet, at \$1.25 | 325.00 |
| 20-inch drain, 2,090 feet, at \$1.55 | 3,239.50 |
| 24-inch drain, 1,000 feet, at \$2.10 | 2,100.00 |
| 26-inch drain, 1,900 feet, at \$2.20 | 4,180.00 |
| 28-inch drain, 830 feet, at \$2.40 | 1,992.00 |
| 38-inch drain, 990 feet, at \$4.60 | 2,714.00 |
| 42-inch drain, 280 feet, at \$5 | 1,400.00 |
| 46-inch drain, 250 feet, at \$5.40 | 1,350.00 |
| 48-inch drain, 470 feet, at \$5.60 | 2,632.00 |
| Manholes, 41, at \$40 | 1,640.00 |
| Inlets, 180, at \$12 | 2,160.00 |

| | |
|-----------------------------------------|-----------|
| | 24,398.50 |
| Add 10 per cent for contingencies | 2,439.85 |

| | |
|-------------|-----------|
| Total | 26,838.35 |
|-------------|-----------|

Belascoain system (north):

| | |
|--------------------------------------------|----------|
| 12-inch drain, 230 feet, at \$0.60 | 138.00 |
| 15-inch drain, 1,010 feet, at \$0.90 | 909.00 |
| 18-inch drain, 1,270 feet, at \$1.25 | 1,587.50 |
| 20-inch drain, 800 feet, at \$1.55 | 1,240.00 |
| 24-inch drain, 560 feet, at \$2.10 | 1,176.00 |
| 26-inch drain, 100 feet, at \$2.20 | 220.00 |
| 32-inch drain, 410 feet, at \$4 | 1,640.00 |
| 34-inch drain, 250 feet, at \$4.20 | 1,050.00 |
| 36-inch drain, 1,180 feet, at \$4.40 | 5,192.00 |
| 42-inch drain, 1,344 feet, at \$5 | 6,720.00 |
| Manholes, 28, at \$40 | 1,120.00 |
| Inlets, 192, at \$12 | 2,304.00 |

| | |
|-----------------------------------------|-----------|
| | 23,296.50 |
| Add 10 per cent for contingencies | 2,329.65 |

| | |
|-------------|-----------|
| Total | 25,626.15 |
|-------------|-----------|

Prado system:

| | |
|--------------------------------------------|----------|
| 12-inch drain, 280 feet, at \$0.60 | 168.00 |
| 20-inch drain, 580 feet, at \$1.55 | 899.00 |
| 24-inch drain, 1,300 feet, at \$2.10 | 2,730.00 |
| 32-inch drain, 330 feet, at \$4 | 1,320.00 |
| 38-inch drain, 460 feet, at \$4.60 | 2,116.00 |
| 40-inch drain, 360 feet, at \$4.80 | 1,728.00 |
| Manholes, 12, at \$40 | 480.00 |
| Inlets, 48, at \$12 | 576.00 |

| | |
|-----------------------------------------|-----------|
| | 10,017.00 |
| Add 10 per cent for contingencies | 1,001.70 |

| | |
|-------------|-----------|
| Total | 11,018.70 |
|-------------|-----------|

San Nicholas (north):

| | |
|--------------------------------------------|----------|
| 15-inch drain, 250 feet, at \$0.90 | 225.00 |
| 18-inch drain, 2,560 feet, at \$1.25 | 3,200.00 |

Appendix—Continued.

DRAINAGE SYSTEM.—DETAILED ESTIMATES—continued.

| | | | |
|--------------------------------------------|------------|--------------------------------------------|------------|
| San Nicholas (north)—Continued: | | Zulueta system: | |
| 20-inch drain, 700 feet, at \$1.55 | \$1,085.00 | 15-inch drain, 1,380 feet, at \$0.90 | \$1,242.00 |
| 24-inch drain, 2,010 feet, at \$2.10 | 4,221.00 | 24-inch drain, 680 feet, at \$2.10 | 1,428.00 |
| 26-inch drain, 640 feet, at \$2.20 | 1,408.00 | 28-inch drain, 320 feet, at \$2.40 | 768.00 |
| 30-inch drain, 920 feet, at \$2.50 | 2,300.00 | 34-inch drain, 1,180 feet, at \$4.20 | 4,956.00 |
| 32-inch drain, 560 feet, at \$4 | 2,240.00 | 38-inch drain, 250 feet, at \$4.60 | 1,150.00 |
| 40-inch drain, 480 feet, at \$4.80 | 2,304.00 | Manholes, 14, at \$40 | 560.00 |
| 42-inch drain, 240 feet, at \$5 | 1,200.00 | Inlets, 54, at \$12 | 648.00 |
| 50-inch drain, 220 feet, at \$5.80 | 1,276.00 | | |
| 52-inch drain, 300 feet, at \$6 | 1,800.00 | | |
| Manholes, 37, at \$40 | 1,480.00 | | |
| Inlets, 150, at \$12 | 1,800.00 | | |
| | | | |
| | 24,539.00 | Add 10 per cent for contingencies | 10,752.00 |
| Add 10 per cent for contingencies | 2,453.90 | | 1,075.20 |
| Total | 26,992.90 | Total | 11,827.20 |
| | | | |
| Obrapia system: | | Justiz system: | |
| 18-inch drain, 230 feet, at \$1.25 | 287.50 | 15-inch drain, 330 feet, at \$0.90 | 297.00 |
| Manholes, 2, at \$40 | 80.00 | 18-inch drain, 300 feet, at \$1.25 | 375.00 |
| Inlets, 8, at \$12 | 96.00 | 20-inch drain, 440 feet, at \$1.55 | 682.00 |
| | | 32-inch drain, 270 feet, at \$4 | 1,080.00 |
| | | Manholes, 6, at \$40 | 240.00 |
| | | Inlets, 28, at \$12 | 336.00 |
| | | | |
| | 463.50 | | |
| Add 10 per cent for contingencies | 46.35 | Add 10 per cent for contingencies | 3,010.00 |
| Total | 509.85 | Total | 3,311.00 |

Summary of costs for drainage system.

| | | | |
|-----------------------------------|-------------|---------------------------------|------------|
| Mercaderes system | \$46,451.90 | Pilar system | \$3,062.40 |
| Santa Clara system | 688.60 | Oquendo system (north) | 37,213.00 |
| Sol system | 1,323.85 | Principe system | 9,039.80 |
| Lamparilla system | 53,684.40 | Oquendo system (south) | 21,235.50 |
| Belascoain system (south) | 5,679.30 | Luz system | 12,601.05 |
| Industria system | 24,475.00 | Compostela system | 7,213.80 |
| Agulla system | 55,139.15 | Lealtad system | 26,838.35 |
| Factoria system | 18,783.05 | Belascoain system (north) | 25,626.15 |
| Chacon system | 5,594.60 | Prado system | 11,018.70 |
| Arbol Seco system | 53,380.25 | San Nicolas (north) | 26,992.90 |
| Acosta system | 20,956.10 | Obrapia system | 509.85 |
| Pefia Pobre system | 989.45 | Zulueta system | 11,827.20 |
| San Nicholas system (south) | 48,108.50 | Justiz system | 3,311.00 |
| Cuba system | 6,506.50 | | |
| Gervasio system | 35,839.65 | Total | 574,090.00 |

The estimate for the drainage system is made upon the assumption that the drains will be laid at the same time of the sewerage system and in the same trench. The cost of trenching is not included in the estimates for this system.

| | |
|-------------------------------------------|--------------|
| Matadero storm drain: | |
| 14-foot drain, 2,700 feet, at \$60 | \$612,000.00 |
| 13½-foot drain, 1,120 feet, at \$45 | 50,400.00 |
| 12½-foot drain, 880 feet, at \$30 | 26,400.00 |
| 11½-foot drain, 300 feet, at \$25 | 7,500.00 |
| Manholes, 25, at \$50 | 1,250.00 |
| Changes in bridges | 25,000.00 |
| | |
| | 272,550.00 |
| Add 10 per cent for contingencies | 27,255.00 |
| Total | 299,805.00 |

Sewerage system.—Detailed estimates.

| | | | |
|------------------------------------|-------------|--------------------------------------------|------------|
| East side marginal sewer: | | East side marginal sewer—Continued: | |
| 114-inch concrete sewer, brick in- | | 28-inch concrete sewer, brick in- | |
| vert, 390 feet, at \$41.05 | \$16,009.50 | vert, 460 feet, at \$4.60 | 2,116.00 |
| 54-inch concrete sewer, brick in- | | 20-inch pipe sewer, 1,820 feet, at | |
| vert, 430 feet, at \$20 | 8,600.00 | \$3.20 | 5,824.00 |
| 46-inch concrete sewer, brick in- | | 18-inch pipe sewer, 720 feet, at \$2.55 | 1,836.00 |
| vert, 1,590 feet, at \$12.80 | 20,352.00 | | |
| 44-inch concrete sewer, brick in- | | | |
| vert, 640 feet, at \$11.20 | 7,168.00 | Add 10 per cent for contingencies | 94,776.50 |
| 40-inch concrete sewer, brick in- | | | 9,477.65 |
| vert, 1,730 feet, at \$11.10 | 19,203.00 | Total | 104,254.15 |
| 38-inch concrete sewer, brick in- | | | |
| vert, 410 feet, at \$9.30 | 3,813.00 | North side marginal sewer: | |
| 34-inch concrete sewer, brick in- | | 84-inch concrete sewer, brick in- | |
| vert, 150 feet, at \$8.30 | 1,245.00 | vert, 1,000 feet, at \$34.30 | 34,300.00 |
| 32-inch concrete sewer, brick in- | | 82-inch concrete sewer, brick in- | |
| vert, 1,050 feet, at \$8.20 | 8,610.00 | vert, 2,990 feet, at \$23.30 | 69,667.00 |

Sewerage system.—Detailed estimates—Continued.

| | | | |
|-------------------------------------------------------------------|-------------|-------------------------------------------------------------------|-------------|
| North side marginal sewer—Continued: | | Jesus del Monte main sewer: | |
| 80-inch concrete sewer, brick invert, 2,020 feet, at \$22.80..... | \$46,056.00 | 38-inch concrete sewer, brick invert, 2,380 feet, at \$16.10..... | \$38,318.00 |
| 78-inch concrete sewer, brick invert, 1,100 feet, at \$18.85..... | 20,735.00 | 34-inch concrete sewer, brick invert, 390 feet, at \$8.70..... | 3,393.00 |
| | 170,758.00 | 26-inch concrete sewer, brick invert, 390 feet, at \$5.10..... | 1,989.00 |
| Add 10 per cent for contingencies..... | 17,075.80 | 24-inch brick sewer, brick invert, 330 feet, at \$5.30..... | 1,749.00 |
| Total..... | 187,833.80 | 15-inch pipe sewer, 2,490 feet, at \$3.50..... | 8,715.00 |
| Hospital street main sewer: | | 12-inch pipe sewer, 1,100 feet, at \$3..... | 3,300.00 |
| 70-inch brick sewer in tunnel, 3,500 feet, at \$31.80..... | 111,300.00 | | 57,464.00 |
| 74-inch concrete sewer, brick invert, 1,090 feet, at \$30.70..... | 33,463.00 | Add 10 per cent for contingencies..... | 5,746.40 |
| | 144,763.00 | Total..... | 63,210.40 |
| Add 10 per cent for contingencies..... | 14,476.30 | | |
| Total..... | 159,239.30 | Christina marginal sewer: | |
| South side high-level marginal sewer: | | 36-inch concrete sewer, brick invert, 1,760 feet, at \$8..... | 14,080.00 |
| 66-inch concrete sewer, brick invert, 1,000 feet, at \$25.55..... | 25,550.00 | 32-inch concrete sewer, brick invert, 1,890 feet, at \$6.80..... | 12,852.00 |
| 64-inch concrete sewer, brick invert, 2,740 feet, at \$27.30..... | 74,802.00 | 26-inch brick sewer, brick invert, 160 feet, at \$4.40..... | 704.00 |
| | 100,352.00 | 24-inch brick sewer, brick invert, 570 feet, at \$5.55..... | 3,163.50 |
| Add 10 per cent for contingencies..... | 10,035.20 | 20-inch pipe sewer, 530 feet, at \$4..... | 2,120.00 |
| Total..... | 110,387.20 | 16-inch cast-iron pipe, siphon, 100 feet, at \$5.55..... | 555.00 |
| Cerro and Jesus del Monte main sewer: | | | 33,474.50 |
| 74-inch concrete sewer, brick invert, 250 feet, at \$19.30..... | 4,825.00 | Add 10 per cent for contingencies..... | 3,347.45 |
| 70-inch concrete sewer, brick invert, 2,330 feet, at \$17.20..... | 40,076.00 | Total..... | 36,821.95 |
| 62-inch concrete sewer, brick invert, 330 feet, at \$17.85..... | 5,890.50 | | |
| 30-inch cast iron pipe, siphon, 200 feet, at \$12.60..... | 2,520.00 | South side marginal sewer: | |
| | 53,311.50 | 34-inch concrete sewer, brick invert, 670 feet, at \$7.80..... | 5,226.00 |
| Add 10 per cent for contingencies..... | 5,331.15 | 26-inch brick sewer, 2,320 feet, at \$5.05..... | 11,716.00 |
| Total..... | 58,642.65 | | 16,942.00 |
| North Cerro main sewer: | | Add 10 per cent for contingencies..... | 1,694.20 |
| 28-inch concrete sewer, brick invert, 2,590 feet, at \$6.15..... | 15,928.50 | Total..... | 18,636.20 |
| 18-inch pipe sewer, 560 feet, at \$3.25..... | 1,820.00 | | |
| | 17,748.50 | Marina main sewer: | |
| Add 10 per cent for contingencies..... | 1,774.85 | 58-inch concrete sewer, brick invert, 1,080 feet, at \$12.40..... | 13,392.00 |
| Total..... | 19,523.35 | 56-inch concrete sewer, brick invert, 1,250 feet, at \$11.95..... | 14,937.50 |
| South Cerro and Jesus del Monte main sewer: | | | 28,329.50 |
| 54-inch concrete sewer, brick invert, 300 feet, at \$22.40..... | 6,720.00 | Add 10 per cent for contingencies..... | 2,832.95 |
| 52-inch concrete sewer, brick invert, 2,620 feet, at \$20.30..... | 53,186.00 | Total..... | 31,162.45 |
| 50-inch concrete sewer, brick invert, 2,960 feet, at \$19.50..... | 57,720.00 | | |
| | 117,626.00 | Belascoain main sewer: | |
| Add 10 per cent for contingencies..... | 11,762.60 | 30-inch brick sewer, 690 feet, at \$5.40..... | 3,726.00 |
| Total..... | 129,388.60 | 28-inch brick sewer, 260 feet, at \$5.20..... | 1,352.00 |
| South Cerro main sewer: | | 26-inch brick sewer, 300 feet, at \$4.50..... | 1,350.00 |
| 20-inch pipe sewer, 360 feet, at \$4.10..... | 1,476.00 | | 6,428.00 |
| 18-inch pipe sewer, 2,360 feet, at \$3.50..... | 8,260.00 | Add 10 per cent for contingencies..... | 642.80 |
| 15-inch pipe sewer, 1,800 feet, at \$2.75..... | 4,950.00 | Total..... | 7,070.80 |
| 12-inch pipe sewer, 260 feet, at \$2.80..... | 728.00 | | |
| 10-inch pipe sewer, 260 feet, at \$1.90..... | 494.00 | DISTRICT SEWERS. | |
| | 15,908.00 | East side district: | |
| Add 10 per cent for contingencies..... | 1,590.80 | 8-inch pipe sewer, 85,800 feet, at \$1.20..... | 102,960.00 |
| Total..... | 17,498.80 | 10-inch pipe sewer, 7,550 feet, at \$1.35..... | 10,192.50 |
| | | 12-inch pipe sewer, 4,360 feet, at \$1.45..... | 6,322.00 |
| | | 15-inch pipe sewer, 3,770 feet, at \$1.80..... | 6,786.00 |
| | | 18-inch pipe sewer, 1,820 feet, at \$2.20..... | 4,004.00 |
| | | 20-inch pipe sewer, 300 feet, at \$2.50..... | 750.00 |

Sewerage system.—Detailed estimates—Continued.

DISTRICT SEWERS—continued.

East side district—Continued:

| | |
|----------------------------------------|------------|
| Flush tanks, 37, at \$100..... | \$3,700.00 |
| Manholes, 435, at \$60..... | 26,100.00 |
| | <hr/> |
| | 160,814.50 |
| Add 10 per cent for contingencies..... | 16,081.00 |
| | <hr/> |
| Total | 176,895.95 |

North side district:

| | |
|-------------------------------------------------|------------|
| 8-inch pipe sewer, 107,250 feet, at \$1.20..... | 128,700.00 |
| 10-inch pipe sewer, 19,630 feet, at \$1.35..... | 26,500.50 |
| 12-inch pipe sewer, 8,000 feet, at \$1.45..... | 11,600.00 |
| 15-inch pipe sewer, 4,460 feet, at \$1.80..... | 8,028.00 |
| 18-inch pipe sewer, 1,280 feet, at \$2.20..... | 2,816.00 |
| 20-inch pipe sewer, 280 feet, at \$2.50..... | 700.00 |
| Flush tanks, 36, at \$100..... | 3,600.00 |
| Manholes, 547, at \$60..... | 32,820.00 |
| | <hr/> |
| | 214,764.50 |
| Add 10 per cent for contingencies..... | 21,476.45 |
| | <hr/> |
| Total | 236,240.95 |

South side, high-level district:

| | |
|------------------------------------------------|-----------|
| 8-inch pipe sewer, 35,900 feet, at \$1.20..... | 43,080.00 |
| 10-inch pipe sewer, 2,250 feet, at \$1.35..... | 3,037.50 |
| 12-inch pipe sewer, 250 feet, at \$1.45..... | 362.50 |
| 18-inch pipe sewer, 820 feet, at \$2.20..... | 1,804.00 |
| 20-inch pipe sewer, 280 feet, at \$2.50..... | 700.00 |
| 24-inch brick sewer, 310 feet, at \$3.45..... | 1,069.50 |
| Flush tanks, 12, at \$100..... | 1,200.00 |
| Manholes, 172, at \$60..... | 10,320.00 |
| | <hr/> |
| | 61,573.50 |
| Add 10 per cent for contingencies..... | 6,157.35 |
| | <hr/> |
| Total | 67,730.85 |

North Matadero district:

| | |
|------------------------------------------------|-----------|
| 8-inch pipe sewer, 42,000 feet, at \$1.20..... | 50,400.00 |
| 10-inch pipe sewer, 1,877 feet, at \$1.35..... | 2,524.50 |
| 12-inch pipe sewer, 2,080 feet, at \$1.45..... | 3,016.00 |
| 15-inch pipe sewer, 950 feet, at \$1.80..... | 1,710.00 |
| 20-inch pipe sewer, 480 feet, at \$2.50..... | 1,200.00 |
| 24-inch brick sewer, 720 feet, at \$3.45..... | 2,484.00 |
| Flush tanks, 22, at \$100..... | 2,200.00 |
| Manholes, 214, at \$60..... | 12,840.00 |
| | <hr/> |
| | 76,374.50 |
| Add 10 per cent for contingencies..... | 7,637.45 |
| | <hr/> |
| Total | 84,011.95 |

South Matadero district:

| | |
|------------------------------------------------|-----------|
| 8-inch pipe sewer, 27,100 feet, at \$1.20..... | 32,520.00 |
| 10-inch pipe sewer, 3,310 feet, at \$1.35..... | 4,468.50 |
| 12-inch pipe sewer, 1,310 feet, at \$1.45..... | 1,899.50 |
| 15-inch pipe sewer, 1,770 feet, at \$1.80..... | 3,186.00 |
| 18-inch pipe sewer, 760 feet, at \$2.20..... | 1,672.00 |
| 20-inch pipe sewer, 230 feet, at \$2.50..... | 575.00 |

DISTRICT SEWERS—continued.

South Matadero district:

| | |
|----------------------------------------|------------|
| Flush tanks, 12, at \$100..... | \$1,200.00 |
| Manholes, 135, at \$60..... | 8,100.00 |
| | <hr/> |
| | 53,621.00 |
| Add 10 per cent for contingencies..... | 5,362.10 |
| | <hr/> |
| Total | 58,983.10 |

Cerro district:

| | |
|------------------------------------------------|------------|
| 8-inch pipe sewer, 61,470 feet, at \$1.20..... | 73,764.00 |
| 10-inch pipe sewer, 4,720 feet, at \$1.35..... | 6,372.00 |
| 12-inch pipe sewer, 2,280 feet, at \$1.45..... | 3,306.00 |
| 15-inch pipe sewer, 3,490 feet, at \$1.80..... | 6,282.00 |
| 18-inch pipe sewer, 1,200 feet, at \$2.20..... | 2,640.00 |
| 20-inch pipe sewer, 850 feet, at \$2.50..... | 2,125.00 |
| 24-inch brick sewer, 270 feet, at \$3.45..... | 931.50 |
| Flush tanks, 23 ft., at \$100..... | 2,300.00 |
| Manholes, 289 ft., at \$60..... | 17,340.00 |
| | <hr/> |
| | 115,060.50 |
| Add 10 per cent for contingencies..... | 11,506.05 |
| | <hr/> |
| Total | 126,566.55 |

Jesus del Monte district:

| | |
|------------------------------------------------|-----------|
| 8-inch pipe sewer, 25,000 feet, at \$1.20..... | 30,000.00 |
| 10-inch pipe sewer, 640 feet, at \$1.35..... | 864.00 |
| Flush tanks, 14 ft., at \$100..... | 1,400.00 |
| Manholes, 112 ft., at \$60..... | 6,720.00 |
| | <hr/> |
| | 38,984.00 |
| Add 10 per cent for contingencies..... | 3,898.40 |
| | <hr/> |
| Total | 42,882.40 |

Force main from low district pumping station:

| | |
|----------------------------------------------------|-----------|
| 36-inch cast-iron pipe, 1,480 feet, at \$9.50..... | 14,060.00 |
| Add 10 per cent for contingencies..... | 1,406.00 |
| | <hr/> |
| Total | 15,466.00 |

Discharge well at Punta:

| | |
|-----------------------------------------------|----------|
| 10 feet diameter, 19 feet deep. | |
| 83 cubic yards rock excavation, at \$6..... | 498.00 |
| Brick lining, 31.50 cubic yards, at \$23..... | 724.50 |
| Plastering, 50 square yards, at \$1..... | 50.00 |
| | <hr/> |
| | 1,272.50 |
| Add 10 per cent for contingencies..... | 127.25 |
| | <hr/> |
| Total | 1,399.75 |

Siphon across harbor, riveted steel pipe, 7 feet 3 inches diameter, lined with three rings of brick, 5 feet internal diameter, preparation of bed for two pipes, each 985 feet long:

| | |
|--------------------------------------------------------------------|------------|
| Dredging rock and sand, \$63 per linear foot..... | 62,055.00 |
| Laying pipe, \$100 per foot (2 lines of pipes, each 985 feet)..... | 197,000.00 |
| | <hr/> |
| | 259,055.00 |
| Add 10 per cent for contingencies..... | 25,905.50 |
| | <hr/> |
| Total | 284,960.50 |

Tunnel from discharge well to west end of siphon:

| | |
|--------------------------------------------------------------------------------------------------------|-----------|
| Distance 200 feet, 7 feet internal diameter, lined with three rings of brick, at \$56.35 per foot..... | 11,070.00 |
|--------------------------------------------------------------------------------------------------------|-----------|

Sewerage system.—Detailed estimates—Continued.

DISTRICT SEWERS—continued.

| | |
|----------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Tunnel from discharge well to west end of siphon—Continued: | |
| Tunnel from east end of siphon to pumping station well. Duplicate of above | \$11,070.00 |
| | 22,140.00 |
| Add 10 per cent for contingencies..... | 2,214.00 |
| Total | 24,354.00 |
| El Moro pumping station. (Excavation for gate, cage chambers, and suction well): | |
| 120 by 12 by 24 feet=1,582 cubic yards, at \$6 | 9,492.00 |
| Lining same with three rings of brick, 302 cubic yards, at \$23 | 6,946.00 |
| Pump wells, three each 40 by 10 by 22 feet, excavation 1,290 cubic yards, at \$6 | 7,740.00 |
| Lining same with brick, 310 cubic yards, at \$23 | 7,130.00 |
| Preparing foundation, rock excavation, 400 yards, at \$2 | 800.00 |
| Four 36,000,000 gallon pumping engines, at \$60,000 | 240,000.00 |
| Four 150-horsepower boilers, at \$20 per horsepower | 12,000.00 |
| Engine and boiler house above foundations | 35,000.00 |
| Filth hoists, gates, screens, etc. | 5,000.00 |
| Two force mains, riveted steel pipes, from engine house to west end of tunnel, 5 feet diameter, 100 feet long, 24 tons, at \$140 | 3,360.00 |
| Special castings in pumping house, 12 tons, at \$140 | 1,680.00 |
| Four 48 valves on discharge pipes | 2,500.00 |
| | 331,648.00 |
| Add 10 per cent for contingencies..... | 33,164.80 |
| Total | 364,812.80 |
| Outfall sewer from pumping station: | |
| Tunnel 1,300 feet, 7 feet interior diameter, lined with concrete and brick invert, \$30 per linear foot | 49,400.00 |
| Sewer from east end of tunnel to outfall well, 2,120 feet, 7 feet diameter, concrete, at \$16.25 per foot | 34,450.00 |
| | 83,850.00 |
| Add 10 per cent for contingencies..... | 8,385.00 |
| Total | 92,235.00 |
| Outfall well: | |
| Oblong 14 by 10 by 15 feet deep, rock excavation, 86 cubic yards, at \$5 | 430.00 |

DISTRICT SEWERS—continued.

| | |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Outfall well—Continued: | |
| Three rings of brick on bottom and sides, 28 cubic yards, at \$25 | \$700.00 |
| Shelter house | 500.00 |
| | 1,630.00 |
| Add 10 per cent for contingencies..... | 163.00 |
| Total | 1,793.00 |
| Offshore outfall sewer: | |
| From outfall well to shore line, 100 feet long, trench 9 feet deep by 6 feet wide, at \$8 per foot | 800.00 |
| From shore to depth of 10 meters of water, distance 600 feet, width 8 feet, depth 5 feet, at \$15 per foot 600 feet 60-inch cast-iron pipe, 14-inch thick, 276 tons, at \$30 | 9,000.00 |
| Cost of laying, at \$6 per foot | 8,280.00 |
| | 3,600.00 |
| | 21,680.00 |
| Additional line for future use | 21,680.00 |
| | 43,360.00 |
| Add 10 per cent for contingencies..... | 4,336.00 |
| Total | 47,696.00 |
| South Side pumping station: | |
| Excavation gate and cage chamber, 60 feet long, 10 feet wide, and 10 feet deep, 302 cubic yards, at \$1.50 | 453.00 |
| Brick masonry lining, 1 foot thick, 86 cubic yards, at \$23 | 1,978.00 |
| Concrete foundation for chamber, 100 cubic yards, at \$9 | 900.00 |
| Three pump wells, 30 by 10 by 10 feet=470 cubic yards, at \$1.50 | 705.00 |
| Brick masonry lining, 145 cubic yards, at \$23 | 3,335.00 |
| Concrete house foundations, 100 cubic yards, at \$9 | 900.00 |
| Piling | 1,000.00 |
| Engine and boiler foundations | 6,000.00 |
| Three 8,000,000 gallon pumping engines, at \$25,000 | 75,000.00 |
| Three 75-horsepower boilers, at \$20 per horsepower | 4,500.00 |
| Special cast-iron pipe, 10 tons, at \$1.40 | 1,400.00 |
| Three 36-inch valves | 1,500.00 |
| Hoist, gate screens, etc. | 4,000.00 |
| Engine and boiler houses | 20,000.00 |
| | 121,671.00 |
| Add 10 per cent for contingencies..... | 12,167.10 |
| Total | 133,838.10 |

VEDADO SYSTEM.

| | |
|--------------------------------------------------------------------|-------------|
| High-level marginal sewer: | |
| 56-inch concrete sewer, brick invert, 1,740 feet, at \$11.10 | \$19,314.00 |
| 54-inch concrete sewer, brick invert, 1,150 feet, at \$10.90 | 12,535.00 |
| 44-inch concrete sewer, brick invert, 2,070 feet, at \$9.25 | 19,147.50 |
| 28-inch concrete sewer, brick invert, 2,820 feet, at \$5.75 | 16,215.00 |
| 26-inch concrete sewer, brick invert, 1,970 feet, at \$6.40 | 12,608.00 |
| | 79,819.50 |
| Add 10 per cent for contingencies | 7,981.95 |
| Total | 87,801.45 |

| | |
|--------------------------------------------------------------------|-----------|
| Low-level marginal sewer: | |
| 36-inch concrete sewer, brick invert, 2,130 feet, at \$11.55 | 24,601.50 |

| | |
|-------------------------------------------------------------------|-------------|
| Low-level marginal sewer—Continued: | |
| 32-inch concrete sewer, brick invert, 1,970 feet, at \$6.15 | \$12,115.50 |
| 28-inch concrete sewer, brick invert, 790 feet, at \$10.95 | 8,650.50 |
| 26-inch concrete sewer, brick invert, 2,330 feet, at \$5.60 | 13,048.00 |
| 20-inch pipe sewer, 390 feet, at \$1.95 | 760.50 |
| 18-inch pipe sewer, 2,260 feet, at \$1.50 | 3,390.00 |
| 10-inch pipe sewer, 980 feet, at \$4.40 | 4,312.00 |
| 8-inch pipe sewer, 490 feet, at \$2.40 | 1,176.00 |
| | 68,054.00 |
| Add 10 per cent for contingencies | 6,805.40 |
| Total | 74,859.40 |

Sewerage system.—Detailed estimates—Continued.

VEDADO SYSTEM—Continued.

| | |
|--------------------------------------------------------------------------------------|------------|
| Force main in L street (20-inch cast-iron pipe): | |
| 1,015 feet, at \$4..... | \$4,060.00 |
| | 4,060.00 |
| Add 10 per cent for contingencies | 406.00 |
| Total | 4,466.00 |
| Vedado pumping plant, corner Calzada and L streets: | |
| Excavation, gate, cage, and settling chamber yards, at \$3.50 .. | 528.50 |
| Lining same with brick 1 foot thick, 47 cubic yards, at \$23 | 1,081.00 |
| Two pump wells, each 20 by 6 by 10 feet, excavation 143 cubic yards, at \$3.50 | 500.00 |
| Lining same with brick, 62 cubic yards, at \$23 | 1,426.00 |
| Preparing foundations, 300 cubic yards excavation, at \$2 | 600.00 |
| Two 6,000,000-gallon pumping engines, at \$20,000 | 40,000.00 |
| Two 60-horsepower boilers, at \$20 per horsepower | 2,400.00 |
| Two 12-horsepower generators, at \$1,000 each | 2,000.00 |
| Engine and boiler house above foundations | 10,000.00 |
| Two 20-inch valves, at \$150 | 300.00 |
| Hoists, gates, screens, etc | 1,000.00 |
| Special cast-iron pipe, 4 tons, at \$140 | 560.00 |
| | 60,396.00 |
| Add 10 per cent for contingencies | 6,039.60 |
| Total | 66,435.60 |

| | |
|------------------------------------------------|------------|
| Sublift at corner Fifth and B streets: | |
| 10-horsepower motor connections and pump | \$1,200.00 |
| Building and foundations | 1,500.00 |
| | 2,700.00 |
| Add 10 per cent for contingencies | 270.00 |
| Total | 2,970.00 |

| | |
|------------------------------------------------|----------|
| Sublift corner Seventh and Sixteenth streets: | |
| 5-horsepower motor connections and pumps | 800.00 |
| Building and foundations | 1,400.00 |
| | 2,200.00 |
| Add 10 per cent for contingencies | 220.00 |
| Total | 2,420.00 |

| | |
|-------------------------------------------------------|------------|
| Regla and Casa Blanca system: | |
| Siphon, 16-inch cast-iron pipe, flexible joints | 35,680.00 |
| Pumping plant at Casa Blanca— | |
| Two 4,000,000-gallon pumps .. | 36,000.00 |
| Boilers | 6,000.00 |
| Foundations and piping | 8,000.00 |
| Engine and boiler house | 20,000.00 |
| Hoists, valves, screens, etc | 3,600.00 |
| Pump wells, etc | 12,000.00 |
| Force main and sewer to outfall | 30,000.00 |
| | 151,280.00 |
| Add 10 per cent for contingencies | 15,128.00 |
| Total | 166,408.00 |

SUMMARY OF COSTS FOR SEWERAGE SYSTEM.

| | |
|--------------------------------------------------|--------------|
| East side marginal sewer | \$104,254.15 |
| North side marginal sewer | 187,833.80 |
| Hospital street main sewer | 159,239.30 |
| South side high-level marginal sewer | 110,387.20 |
| Cerro and Jesus del Monte main sewer | 58,642.65 |
| North Cerro main sewer | 19,523.35 |
| South Cerro and Jesus del Monte main sewer | 120,388.60 |
| South Cerro main sewer | 17,498.80 |
| Jesus del Monte main sewer | 63,210.40 |
| Cristina marginal sewer | 36,821.95 |
| South side marginal sewer | 18,636.20 |
| Marina main sewer | 31,162.45 |
| Belascoain main sewer | 7,070.80 |
| East side district | 176,895.95 |
| North side district | 236,240.95 |
| South side high level district | 67,730.85 |
| North Matadero district | 84,011.95 |
| South Matadero district | 56,983.10 |
| Cerro district | 126,566.55 |
| Jesus del Monte district | 42,882.40 |

| | |
|------------------------------------------------|--------------|
| Carmen force main | \$15,466.00 |
| Discharge well at Punta | 1,399.75 |
| Siphon across harbor | 284,960.50 |
| Tunnels at end of siphon | 24,354.00 |
| El Morro pumping station | 364,812.80 |
| Outfall sewer from pumping station .. | 92,235.00 |
| Outfall well | 1,793.00 |
| Offshore outfall sewer | 47,696.00 |
| South side pumping station | 133,838.10 |
| High-level marginal sewer, Vedado system | 87,801.45 |
| Low-level marginal sewer, Vedado system | 74,859.40 |
| Force main in L street | 4,466.00 |
| Vedado pumping plant | 66,435.60 |
| Sublift at corner Fifth and B streets .. | 2,970.00 |
| Sublift at corner Seventh and Sixteenth .. | 2,420.00 |
| Pumping station at Casa Blanca, etc .. | 166,408.00 |
| Total | 3,108,897.00 |

NOTES ON THE ESTIMATES.

Concrete for the sewers:
 Portland cement, 1 part; sand, 2 parts;
 broken stone, 3 parts.
 Portland cement, \$3.50 per barrel including duty.
 Sand (imported), \$4.50 per cubic yard.

| | |
|---------------------------------------------------------|--------|
| Cost per yard: | |
| 13 barrels of cement, at \$3.50 | \$6.12 |
| 0.4 cubic yard sand, at \$4.50 | 1.80 |
| Three-quarters cubic yard broken stone, at \$1.75 | 1.31 |
| Labor, per cubic yard | 1.50 |
| Total | 10.73 |

[Estimated at \$11 per cubic yard.]

| | |
|---------------------------------------------------------|---------|
| Vitrified brick work (cost per cubic yard, 450 bricks): | |
| 450 bricks, at \$37.50 per 1,000, including duty | \$16.87 |
| 1 barrel Portland cement, at \$3.50 | 3.50 |
| Sand | .75 |
| Labor | 1.50 |
| Total | 22.62 |

Sewerage system.—Detailed estimates—Continued.

COST OF VITRIFIED SEWER PIPE.

[Estimated at \$23 per cubic yard. Prices of pipe are from manufacturers, delivered at wharf, Habana.]

| Size. | Price of pipe. | Unloading. | Duty. | Laying in trench. | Total. | Price as used. |
|--------------|----------------|------------|--------|-------------------|---------|----------------|
| 20-inch..... | \$1.125 | \$0.10 | \$0.12 | \$0.20 | \$1.545 | \$1.55 |
| 18-inch..... | .833 | .08 | .10 | .20 | 1.213 | 1.25 |
| 15-inch..... | .57 | .06 | .10 | .15 | .88 | .90 |
| 12-inch..... | .395 | .04 | .08 | .10 | .615 | .60 |
| 10-inch..... | .31 | .03 | .07 | .08 | .49 | .50 |
| 8-inch..... | .21 | .02 | .06 | .06 | .35 | .35 |
| 6-inch..... | .1425 | .02 | .04 | .04 | .2425 | .25 |

The above prices for laying do not include cost of trenching.

Manholes are estimated at an average of \$60 each, including frame cover and steps.

Flush tanks are estimated at an average of \$100 each, including all iron work.

Inlets to the storm drains are also averaged at \$12 each, including the 8-inch or 12-inch pipe to the drain.

Cast-iron pipe, \$30 per ton of 2,000 pounds.

Steel riveted pipe, 7 cents per pound completed.

Special castings, 7 cents per pound.

ESTIMATED COST OF THAT PORTION OF THE WORKS THE BUILDING OF WHICH CAN BE DEFERRED.

| | | | |
|------------------------------------|--------------|---------------------------------|-------------|
| One siphon pipe under harbor | \$108,350.00 | Vedado system: | |
| Two 36,000-gallon pumps | 132,000.00 | High-level marginal sewer | \$87,801.45 |
| Two 300-horsepower boilers | 6,600.00 | Low-level marginal sewer | 74,859.40 |
| One force main | 1,848.00 | Force main | 4,466.00 |
| Two 4-foot valves | 1,375.00 | Vedado pumping plant | 66,435.60 |
| One outfall sewer | 23,848.00 | Sublifts | 5,390.00 |
| One 8,000-gallon pump | 27,500.00 | Regla and Casa Blanca | 166,408.00 |
| One 75-horsepower boiler | 1,650.00 | | |
| One 3-foot valve | 550.00 | Total | 709,081.45 |

During the past twelve months the force of the sewer department has been engaged in removing deposits from the main sewers and from open ditches carrying sewage. All the main closed sewers have been cleaned thoroughly, and the old solid deposits entirely removed. As there are no manholes provided to the existing sewers, it is necessary to make openings in the pavement and remove the crown of the sewer, which is both laborious and expensive. In many of the streets the foundation of the pavement rests directly upon the crown of the sewer, which frequently causes the crown to collapse, requiring the services of one gang to make repairs.

The sewage from the Cerro and Jesus del Monte districts is carried through plank-covered ditches which pass along both sides of the roadway. All adjoining house drains empty directly into them. Access to these ditches is obtained by removing the plank covering; and as often as the conditions demand, the solid deposit is removed without delay in carts to dump scows, which carry it to sea. Both material and trenches are liberally disinfected with electrozone and chloride of lime while the work of removing the deposits is being carried on.

As a result of the work accomplished by this department during the past year, the sewers and ditches are in a fair sanitary condition. Many of the old rectangular tile and brick house drains have been abandoned by the owners of houses, and requests are being received daily for permits to lay 4 or 6 inch vitrified clay pipes in their stead. These permits have been granted, and the direction of the work of laying the pipe is under the supervision of a competent house drain and plumbing inspector. Much difficulty is experienced in trying to con-

vince the owners of property and local contractors of the advantage of following the ordinary rules of sanitary plumbing, such as the running trap, the grease trap, and the importance of the vent pipe, as well as care in securing tight and permanent joints to all connections. It can safely be asserted that no plumbing work up to the modern standard had been done in Habana prior to January, 1899. This class of work was done by tradesmen other than qualified plumbers; as a consequence, the plumbing done in most instances is bad and should be repaired.

During the past year proper plans and specifications have been prepared by the department and furnished to all applying for permission to erect or reconstruct buildings. Competent inspecting plumbers have been employed by the department to look after the work, with a view of following the best practice for this class of work.

No permanent improvement will result until a plumbing ordinance is established governing the construction of sanitary work, and proper qualification of those who follow the trade. In anticipation of the promulgation of a new charter for the city, the main features of a plumbing ordinance have been drafted by the department.

Levels were taken and profiles platted of all the streets within the corporate limits of the city, for the purpose of having correct data on which to base the design for a new plan of main drainage for the city. Seven monuments have been constructed and placed at convenient points, and their (relative) elevations determined, using low tide as the datum plane. The elevations of these monuments are taken as standard for all public work.

Report of work done by sewer department, from July 1, 1899, to June 30, 1900, both dates inclusive.

| | |
|-------------------------------------------------------|----------|
| Number of linear feet of closed sewer cleaned | 15, 835 |
| Number of linear feet of open ditch cleaned | 127, 038 |
| Number of breaks in sewers repaired | 749 |
| Number of linear feet of new sewers constructed | 703 |
| Number of times cleaning of catch basins..... | 8, 858 |
| Number of cart days..... | 3, 432 |
| Cost per cart day, \$3..... | |
| Average number of loads removed per cart day..... | 4, 328 |
| Number of loads of dirt removed | 14, 854 |
| Total number of pounds of quicklime used | 408, 830 |
| Total number of pounds of chloride of lime used..... | 4, 924 |

NIGHT SOIL REMOVAL.

Attention is respectfully invited to the schedule of work accomplished during the year by the night-soil department. The force employed in this branch of the engineer department was engaged in operating 4 tank wagons for the distribution of electrozone to public and private cesspools and sewer catch basins, and 12 iron sanitary carts (the tanks of which are securely closed), used exclusively for the removal of night soil. These carts have a capacity each of 1 cubic yard. There are also engaged in this latter work several large private plants.

The city ordinance provides that the removal of night soil shall be carried on only between the hours of 10 p. m. and 4 a. m., which somewhat curtails the quantity of work that should be accomplished,

in view of the large number of cesspools requiring cleaning in all parts of the city.

The department plant is engaged principally in cleaning cesspools which have become full and foul, and whose owners failed to have the work done after receiving due notice from the chief sanitary officer. The department then performs the necessary cleaning, for which a bill is rendered covering the cost of the work, and collected under process of law. Many proprietors prefer the service of the department to that of private contractors. The charge collected for the public service is at the rate of \$2.50 per cubic yard.

Excavators with hose attachments are used to remove all liquid and semiliquid matter from cesspools, direct from the cesspool within the premises to the cart standing in front of the house. When the character of the material will not permit this process the soil is put in closed sanitary buckets and carried to and deposited in the waiting carts. The carts convey their contents to the dump scow to be carried out to sea.

The modern and sanitary methods adopted for this service have been taken up and followed by the contractors, who have since abandoned their antiquated ox carts and casks and have purchased mules and iron sanitary carts. The contractors have also materially reduced their price, which formerly was practically prohibitory.

The distribution of electrozone is maintained day and night. The public sewer catch basins in the business portions of the city are daily disinfected; in all other parts biweekly and triweekly; urinals daily.

The outfalls of the main sewers emptying into the bay are supplied automatically with electrozone through tanks kept constantly filled.

Work done at Casa Blanca:

| | |
|-------------------------------------------|-------------|
| Cesspools cleaned and disinfected..... | 19 |
| Night soil removed.....cubic yards.. | 91 |
| Quicklime used.....pounds.. | 3, 400 |
| Night soil removal: | |
| Cesspool inspections..... | 13, 233 |
| Cesspools in an unsanitary condition..... | 6, 945 |
| Cesspools cleaned and disinfected..... | 1, 241 |
| Night soil removed.....cubic yards.. | 9, 697 |
| Pumping liquid to sewer.....hours.. | 206½ |
| Quicklime used.....pounds.. | 127, 020 |
| Disinfection: | |
| Sewer openings disinfected..... | 79, 972 |
| Urinals disinfected..... | 9, 981 |
| Cesspools disinfected..... | 595 |
| Electrozone used.....gallons.. | 3, 555, 656 |

ELECTROZONE PLANT.

[Mr. G. C. Rowe in local charge.]

Previous to October 1, 1899, the plant was operated under the direction of the mechanical engineering department and the street department.

The output of electrozone during the months of August, September, and October, 1899, amounted to about 16,000 gallons per day, with the plant running eight hours and delivering the electrozone at an average strength of 65 grains of available chlorine to the gallon.

This output has increased steadily, so that at the end of June it amounted to 24,800 gallons per day, delivered at an average strength

of 150 grains of available chlorine to the gallon, the plant running fifteen hours without increasing the crew.

Improvements are under way to increase the capacity of the plant, without increasing the cost of labor.

A deposit forms quite rapidly in the tanks in which the electrolytic action takes place. This deposit has been analyzed, showing it to contain hydroxides of zinc, calcium, and magnesium. More careful analyses are now being made.

STATEMENT OF OPERATION OF PLANT.

Number of gallons of electrozone produced in twelve months, 6,469,270.

| | |
|------------------------------------------|------------|
| Total cost of materials (12 months)..... | \$7,616.01 |
| Total cost of labor (12 months)..... | 6,160.70 |
| Royalty (12 months)..... | 3,474.73 |
| Total | 17,251.44 |

Average cost of one gallon of electrozone, \$0.00266667.

Cost of electrozone per 1,000 gallons, of average strength of 150 grains free chlorine, plant running fifteen hours per day, with an output of 24,828.7 gallons per day:

| | |
|------------------------------------------------------------------|----------|
| 483.31 pounds coal | \$1.3291 |
| 102 pounds waste..... | .0015 |
| 0.002 gallons oil..... | .0140 |
| Total cost of material..... | 1.3446 |
| Labor and direction | .66 |
| Royalty per 1,000 gallons | 2.0046 |
| Total cost per 1,000 gallons | 2.7546 |
| $\frac{2.7546}{1000}$ equals total cost per gallon, \$0.0027546. | |

With a view of determining the relative cost of the production of electrozone by adding common salt to the sea water, experiments were made, developing the following results:

Curves taken from two test runs, one with sea water alone, the other with sea water to which salt had been added, show a decided gain in the rate (per unit of time) of electrolytic action when electrozone is made from sea water with salt added.

In making the experiment 440 pounds of salt were added to each of the two tanks in series, or a total of 880 pounds of salt.

The following shows the amount of coal saved thereby:

| | |
|-------------------------------------------|--------|
| Horsepower furnished by two engines | 200 |
| Hours run per day | 15 |
| Horsepower hours | 3,000 |
| Pounds of coal burned per day..... | 12,000 |
| Pounds of coal per horsepower hour | 4 |

Horsepower hours required to produce 2,000 gallons electrozone of 100 grains per gallon—

| | |
|-------------------------------|---------|
| From sea water | 156.139 |
| From sea water with salt..... | 98.132 |
| Horsepower hours saved | 58.007 |

At 4 pounds coal per horsepower hour, coal saved, $4 \times 58.007 = 232.028$ pounds.

| | |
|-----------------------------------------------------|--------|
| Price of salt per pound, \$0.01, total cost..... | \$8.80 |
| Price of coal per pound, \$0.00275, total cost..... | .638 |

| | |
|----------------------------------|-------|
| Additional cost, using salt..... | 8.162 |
|----------------------------------|-------|

While the saving in horsepower hours is 58.007, the cost of salt more than offsets that saving.

Horsepower hours required to produce 2,007 gallons electrozone of 200 grains per gallon—

| | |
|-------------------------------|--------|
| From sea water..... | 320.08 |
| From sea water with salt..... | 209.78 |

| | |
|------------------------------|--------|
| Horsepower hours saved | 110.30 |
|------------------------------|--------|

At 4 pounds of coal per horsepower hour, coal saved, $4 \times 110.30 = 441.21$ pounds.

| | |
|-----------------------------------------------------------|--------|
| Price of salt per pound, \$0.01, total cost of salt | \$8.80 |
| Price of coal per pound, \$0.00275, total cost | 1.2133 |

| | |
|-----------------------------------|--------|
| Additional cost, using salt | 7.5867 |
|-----------------------------------|--------|

While the saving in horsepower hours is 110.3, the cost of salt more than offsets that saving.

| | | |
|---------------------------------------------------------------------------------------------|-------------|--------|
| Calculated output for twenty-four hours for sea water alone, at 200 grains per gallon..... | gallons.. | 30,000 |
| Calculated output for twenty-four hours, sea water with salt, at 200 grains per gallon..... | gallons.. | 45,760 |
| Calculated cost per gallon, 200 grains, sea water | \$0.0034359 | |
| Calculated cost per gallon, 200 grains, sea water with salt added..... | .0072292 | |
| Calculated cost per gallon, 150 grains, sea water | .0027546 | |
| Calculated cost per gallon, 150 grains, sea water with salt added..... | .00668 | |
| Calculated cost per gallon, 100 grains, sea water | .00203426 | |
| Calculated cost per gallon, 100 grains, sea water with salt added..... | .006115226 | |

The saving in time resulting from the addition of salt to the water is more than offset by the cost of the salt, and is, therefore, uneconomical unless the output of the plant is required to be more than 30,000 gallons per twenty-four hours, with a strength of 200 grains free chlorine per gallon.

If the exhaust steam were utilized to evaporate sea water to a greater density, so as to avoid the purchase of salt, a decided economy would result. Steps are being taken looking to this end.

REPORT OF CHLORINE SOLUTION PRODUCED BY THE ACTION OF HYDROCHLORIC ACID UPON A SOLUTION OF CALCIUM HYPOCHLORITE.

Test No. 1, June 9, 1900.—Chloride of lime was taken from the bottom of a barrel at Los Fosos, 1 pound of lime was dissolved in 10 gallons of water, resulting in a milky solution smelling strongly of hypochlorous acid; many small lumps remained floating on top of the liquid, remaining perfectly dry until mashed between the thumb and finger. Test by the arsenous acid method gave 23 per cent or 134.55 grains per gallon for the solution, or a total of 1,345.5 grains of available chlorine in a pound of lime, which gives 19.22 per cent of available chlorine contained in the dry lime. This solution was comparatively stable. Tests taken every two hours showed no appreciable diminution of available chlorine until the end of fourteen hours, when the percentage of available chlorine in the solution was found to be 0.227 per cent or 132.48 grains per gallon. This solution was alkaline to litmus, and was not very active in bleaching qualities, as it bleached blue litmus only after long exposure.

Test No. 2, June 15, 1900.—One pound of a second sample of lime made a solution, in 5 gallons of water, that contained 252.54 grains per gallon of available chlorine, making the percentage of available chlorine in the dry chloride 18.08. To the 5 gallons of solution made with the above sample 5 gallons of water containing one-half pound of commercial hydrochloric acid were added. Free chlorine was freely produced, the odor of which was so strong as to cause the attendant to leave his place for fear of being suffocated. After the bubbles of chlorine gas had ceased to appear, the solution was tested and found to contain only 109.71 grains of chlorine per gallon; less than half the amount it contained before. The bleaching properties were more pronounced, the chlorine acted so promptly that it appeared to be in a nascent state. The milky color of the hypochlorite solution was entirely dispelled by the addition of the hydrochloric acid and a clear green liquid was the result. The green color was due entirely to free chlorine gas in solution, as was afterwards proven by allowing sunlight to fall upon a test tube containing some of the solution, when hydrochloric acid was produced with the liberation of oxygen. As the 10 gallons of solution were found to be still slightly alkaline to litmus one-fourth pound more of HCl was added, with the usual result of much foaming and free chlorine. The resulting solution was acid to litmus and the available chlorine was only 105.57 grains per gallon.

Test No. 3, June 25, 1900.—A sample of calcium hypochlorite taken from a newly opened barrel in Los Fosos was found to contain 23.06 per cent of available chlorine. The United States Pharmacopœia specifies that "0.35 gram of chlorinated lime be titrated with 50 cubic centimeters of water and carefully transferred, together with the washings, into a flask," in making the test for available chlorine in the commercial chloride, and further says that it should contain 35 per cent of available chlorine. Owing to the insoluble nature of a part of the chloride of lime, and the fact that the disinfectant required must be a solution, the chloride contained in the washings must be considered as nonavailable. Hence, the tests made were of the available chlorine that went into solution, and not the total amount of available chlorine contained in the dry lime. This partly accounts for the low percentage found. One pound of this 23.06 per cent hypochlorite was dissolved in 10 gallons of water. Test gave 161.42 grams per gallon, or 276 per cent. Three-fourths of a pound of hydrochloric acid was then added, and the solution tested after effervescence had ceased.

The following table shows loss of available chlorine in mixing, as well as loss after mixing, compared with loss in electrozone:

| Time. | Percent. | Grams per gallon. | Time. | Percent. | Grams per gallon. |
|---------------------------|----------|-------------------|---------------------------|----------|-------------------|
| CHLORINE WATER. | | | CHLORINE WATER—continued. | | |
| <i>Before adding HCl.</i> | | | <i>Before adding HCl.</i> | | |
| June 25: | | | June 26: | | |
| 8 p. m. | 0.276 | 161.42 | 2 a. m. | .241 | 140.76 |
| | | | 4 a. m. | .237 | 138.69 |
| <i>After adding HCl.</i> | | | 6 a. m. | .230 | 134.65 |
| 8 p. m. | .255 | 149.04 | 8 a. m. | .220 | 128.34 |
| 10 p. m. | .252 | 146.97 | 10 a. m. | .202 | 117.99 |
| 12 m. | .244 | 142.83 | 12 m. | .177 | 103.50 |
| | | | 2 p. m. | .120 | 70.38 |

Total time, electrozone, 9½ days.

N. B.—After making the 24-hour test it was observed that by shaking a bottle of this strength a solution of 0.078 per cent or 45.54 grams per gallon was produced.

| Time. | Per cent. | Grams per gallon. | Time. | Per cent. | Grams per gallon. |
|--------------------------------------------|-----------|-------------------------|------------------------|-----------|-------------------------|
| CHLORINE WATER—continued. | | | ELECTROZONE—continued. | | |
| <i>Before adding HCl.</i> | | | [In sun.] | | |
| June 26—Continued. | | | June 25—Continued. | | |
| 4 p. m. | .085 | 49.68 | 7 p. m. | .248 | 144.90 |
| 6 p. m. | .071 | 41.40 | 9 p. m. | .241 | 140.76 |
| 8 p. m. | .067 | 39.33 | 11 p. m. | .241 | 140.76 |
| 10 p. m. | .064 | 37.26 | 1 a. m. | .237 | 138.69 |
| 12 m. | .046 | 26.91 | 3 a. m. | .237 | 138.69 |
| June 27: | | | 5 a. m. | .234 | 136.62 |
| 2 a. m. | .046 | 26.91 | 7 a. m. | .234 | 136.62 |
| 4 a. m. | .042 | 24.84 | 9 a. m. | .230 | 134.55 |
| 6 a. m. | .039 | 22.77 | 11 a. m. | .223 | 130.41 |
| 8 a. m. | .024 | 14.49 | 1 p. m. | .220 | 128.34 |
| 10 a. m. | .000 | 00.00 | 3 p. m. | .216 | 126.27 |
| Or a total loss of chlorine in 7 hours. | | | 3-hour periods. | | |
| ELECTROZONE. | | | 6 p. m. | .209 | 122.13 |
| [In sun.] | | | 9 p. m. | .205 | 120.06 |
| June 25: | | | 12 m. | .202 | 117.99 |
| 3 p. m. | .316 | 184.23 | June 28: | | |
| 5 p. m. | .305 | 178.02 | 3 a. m. | .198 | 115.92 |
| 7 p. m. | .301 | 175.95 | 6 a. m. | .195 | 113.85 |
| 9 p. m. | .298 | 173.88 | 9 a. m. | .188 | 109.71 |
| 11 p. m. | .294 | 171.81 | 24-hour periods. | | |
| 1 a. m. | .291 | 169.74 | June 29, 9 a. m. | .166 | 97.29 |
| 3 a. m. | 0.284 | 165.60 | June 30, 9 a. m. | .142 | 82.80 |
| 5 a. m. | .280 | 162.63 | July 1, 9 a. m. | .134 | 68.66 |
| 7 a. m. | .276 | 161.46 | July 2, 9 a. m. | .0887 | 51.75 |
| 9 a. m. | .273 | 159.39 | July 3, 9 a. m. | .0745 | 43.47 |
| 11 a. m. | .269 | 157.32 | July 4, 9 a. m. | .0640 | 37.26 |
| 1 p. m. | .266 | 155.25 | July 5, 9 a. m. | .0497 | 28.98 |
| 3 p. m. | .259 | 151.40 | | | |
| 5 p. m. | .255 | 149.04 | | | |

At 12 m. the next day after the above-mentioned chlorine solution was made, the sunlight shone in the open barrel in which it was standing, thereby enabling the free chlorine to decompose the water and form hydrochloric acid, which was sufficiently plentiful to redden blue litmus at 2 p. m. As soon as the available Cl. was all gone, which happened in about thirty-nine hours, a sample was placed in a bottle having a glass stopper and set aside, to be used in determining the percentage of HCl present. It was possible to do this July 6, upon the receipt of a normal solution of caustic soda from the city chemist. The solution in the above-mentioned bottle contained 0.272 per cent of hydrochloric acid, thus showing that nearly all the available Cl. had gone to form the hydrochloric acid.

The market price of chloride of lime and hydrochloric acid in Habana, and the resulting price of the disinfectant, are as follows: Chloride of lime, 4 cents per pound (given by property clerk, engineer department); hydrochloric acid, 27.9 per cent, 6 cents per pound (from Dr. Johnson's drug store). Assuming that all the freshly opened barrels of lime contain 23.06 per cent of available chlorine, the following calculation will apply: To 1 pound of calcium chloride (7,000 grams), 4 cents; to $\frac{4}{3}$ pound hydrochloric acid, 27.9 per cent, $4\frac{1}{3}$ cents; 7,000 grams of calcium chloride containing 23.06 per cent, or 1,614.2 grams, of available chlorine would make 10.43 gallons of a disinfectant having a strength of 0.263 per cent, or 154.8 grams per gallon. Deducting 0.43 gallons as loss of chlorine while making this solution, we have cost of 10 gallons of 0.263 per cent of chlorine water $8\frac{1}{2}$ cents, or at the rate of $8\frac{1}{2}$ mills per gallon.

For a disinfectant made of chloride of lime, an acid having a strength of 0.177 per cent, or 103.5 grams per gallon, we have: To 1 pound of chloride of lime, 4 cents; to $\frac{3}{4}$ pound of hydrochloric acid, $4\frac{1}{2}$ cents—cost, 8.5 cents; and as a pound of lime contains 1,614.2 grams of available chlorine, 15.59 gallons could be made having a strength of 0.177 per cent, or 103.5 grams per gallon. Deducting 0.59 gallons as loss of chlorine while making, the cost of 15 gallons of chlorine water is $8\frac{1}{2}$ cents, or 5.66 mills per gallon. For 24,000 gallons, a cost of \$135 per diem.

Actual cost of electrozone having a strength of 0.177 per cent, or 103.5 grams per gallon, for the month of May 1–10 was 2.46 mills per gallon. For 24,000 gallons, \$59.04 per diem. Actual cost of making electrozone, under ordinary normal conditions and with a product of 6,400 gallons 100 grams strength and 26,400 gallons 150 grams strength per day, is for the 100 grams strength \$0.00250, and for 150 grams strength, \$0.00275, which for a strength of 0.263 per cent, or 154.8 grams per gallon, is \$0.002757.

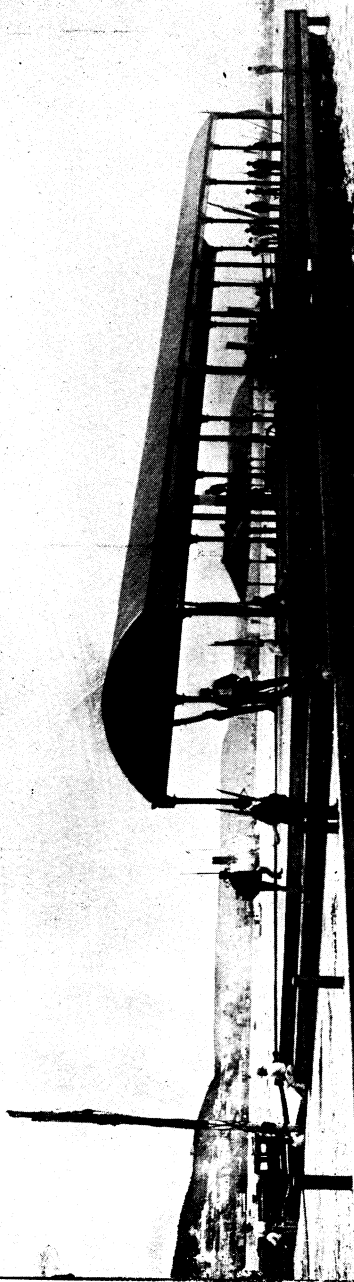
In addition to the above observations it is well to note that true calcium chloride (Ca Cl_2), which is the complement of the action of liberating chlorine when the hypochlorite is treated with hydrochloric acid, forms insoluble Ca CO_3 , calcium carbonate, when in a solution, that is, in contact with the air. Where such a disinfectant is used in large quantities in disinfecting sewers the carbonate deposited might in time interfere with the flowing of the sewage, thereby more than counterbalancing the virtues of the original disinfectant.

Near the end of June the manufacture of electrozone in two strengths was begun. The weaker product (100 grams of available chlorine per gallon) is used in street sprinkling, and the stronger (150 grams of available chlorine per gallon) is employed in the disinfection of all street openings, sewers, etc. The sanitary department is supplied with electrozone in any quantity desired. At present that department is using 9,000 gallons daily of the 150 grams strength. A large quantity is supplied to private individuals for disinfection of private houses, stables, etc., and a small quantity is obtained for medical purposes. The electrozone is furnished free to private individuals calling for it, for the reason that the cost to the state, which is small, is deemed to be more than offset by the measure of safety secured by a free use of the disinfectant.

The average distribution of the full daily production of 36,800 gallons (as manufactured July, 1900) is, approximately, as follows:

| | Gallons. |
|---------------------------------------------------------------------------------------|----------|
| Sewer Department: In disinfecting sewers, ditches, urinals, street openings, etc..... | 15,500 |
| Department street cleaning and parks: | |
| Street sprinkling..... | 7,500 |
| Parks, stables, and dumps..... | 2,000 |
| Department of streets: | |
| Street openings..... | 2,000 |
| Sanitary department..... | 9,000 |
| Private uses..... | 800 |
| Total..... | 36,800 |

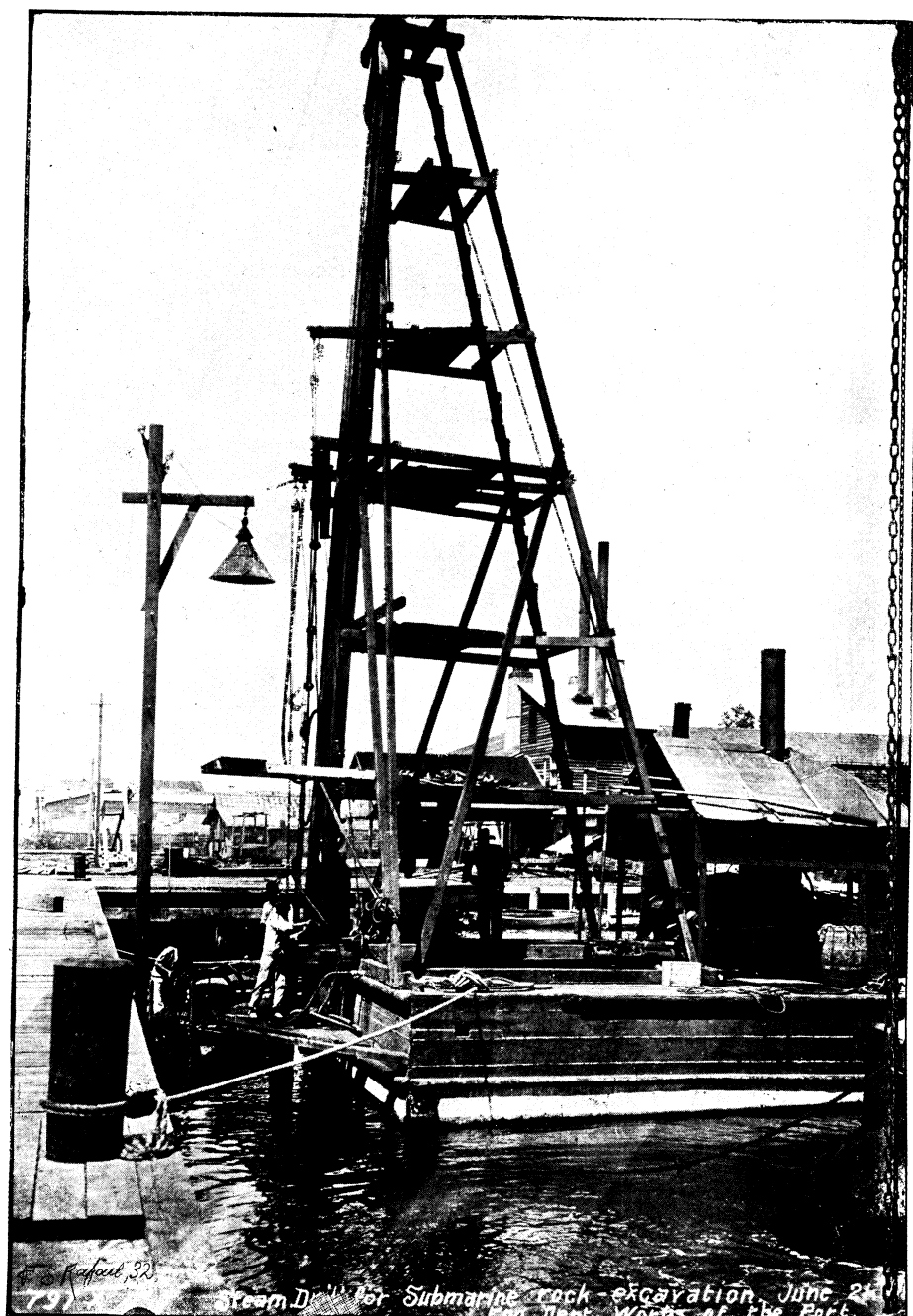
Considerable quantities of electrozone are used from time to time in connection with the sanitation and renovation of public buildings as the work may require.



New Pier and Bulkhead, Pt Luz.
Constructed June 27, 1932. - 06 at 10. AM.
Eng. Dept. II of H.

100 ft. long

NEW PIER AND BULKHEAD AT LUZ.



STEAM DRILL FOR SUBMARINE ROCK EXCAVATION, MOUNTED ON FLOATING PILE DRIVER.

WORKS OF THE PORT.

[Capt. A. H. Weber, assistant engineer in charge.]

This department is practically the same as the Obras del Puerto under the Spanish régime, and the organization and most of the employees are the same. Its principal duties are to construct and maintain the public wharves, dredge channels and shoals, remove wrecks, patrol and keep the harbor front clean, and, by a recent order, inspect the construction and maintenance of private wharves.

ORGANIZATION.

The organization consists of 1 assistant engineer in charge directly under the orders of the chief engineer of the division; 1 assistant engineer in charge of the records of the old Junta de Obras del Puerto, who also acts as consulting engineer; 1 assistant engineer in charge of field work; an office force of 1 clerk, 1 clerk and interpreter, 1 typewriter, 1 draftsman, 1 timekeeper, 1 messenger; 2 steam tug crews, 3 dredging crews, and 1 harbor front cleaning crew. The work is classified under the following heads: "Wharf construction," "Care and repair of old wharves," "Dredging," and "Miscellaneous."

WHARF CONSTRUCTION.

Luz pier No. 1.—This is the northernmost of three piers known as the Luz wharves, located between the Machina and the Ferry slips, extending from a stone bulkhead 150 feet into the bay. For some years this pier has been in a dangerous condition, the outer end leaning at an angle of about 30 degrees, and a total collapse was threatened.

A project for its reconstruction was submitted June 2, and notification of its approval received June 26. The work was started at once, but was not fairly under way until July 1, 1899, and was completed in March, 1900. The plan proposed included the removal of the old pier and its iron shed, the construction of a new bulkhead with necessary filling behind and rebuilding the pier, using such of the old materials as were in good condition. The estimated cost of this work was \$10,436.76, based upon the belief that about one-third of the old materials could be used in the work of reconstruction, and this sum was allotted. It was found, however, upon wrecking the old pier that scarcely any of the materials were in good condition, and on this account and because of many delays in securing new materials, and the necessity of splicing many of the piles, an additional allotment of \$2,400 became necessary, which, with \$676.42 used from the general allotment for work on the wharves, a total of \$13,513.18, represented the sum expended on this pier and bulkhead.

For the betterment of the sanitary conditions in this vicinity, which were bad on account of the angle between Luz and Machina, causing an accumulation of refuse to the extent of completely filling this corner at high tide, the new bulkhead was located 68 feet beyond the old one, on a line between the outer edge of Machina and Paula wharves. It is proposed to extend the bulkhead on this line from time to time as the other piers are rebuilt. The construction of the bulkhead, which has a frontage of 80 feet and a depth of 68 feet, is

similar to that in general use in this harbor. It consisted of a row of 45 native hard-wood piles driven 4 feet centers, the heads of the piles being inclosed by hard-wood waling pieces and the space between the piles filled with sea-palm (miraguano) poles, the whole being capped with a cover of native plank, and backed with a filling of broken stone, lime, cement, mortar, earth, etc., being the waste materials hauled from buildings under construction, and a wall of riprap immediately behind the bulkhead. Anchor piles were also driven about 15 feet back of the bulkhead at intervals of 12 feet, to which the bulkhead was tied with a timber frame at the mud line and again at low water line. At about 30 feet still farther back 2 more piles were driven and tied to the bulkhead with heavy anchor chains. Even with these ties the side bulkhead has sprung 4 inches, but is quite regular in shape, and the bend is not noticeable.

A part of the filling was purchased, but most of it was dumped in free of charge by those in the vicinity who had to dispose of this class of material.

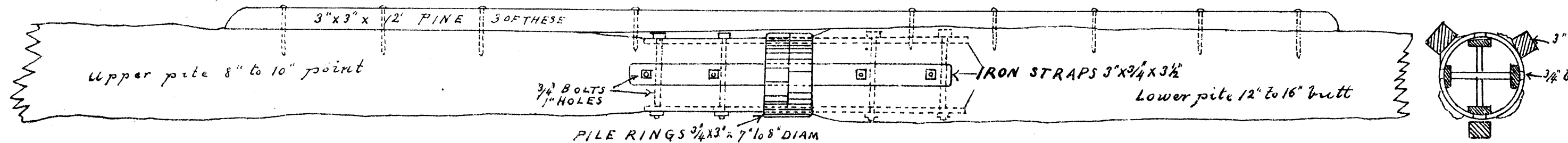
About the center of the pier a 20-inch sewer emptied through the old bulkhead at low-water line. This was extended with vitrified pipe through the filling to the new bulkhead, where it is secured with a heavy wooden frame fastened to the piles of the bulkhead.

This pier is 168 feet in length by 40 feet in width, 8 piles to a bent and bents $12\frac{1}{2}$ feet centers, so as to permit a freer passage of the tidal currents than was possible under the old system of spacing all piles 6 feet between centers. The piles are of native jucaró, the caps and floor timbers of 10 by 12 inch yellow pine, with a border plank of native hard wood. The shed, which is 130 by 20 feet, is of cast-iron columns and beams, wrought trusses, and corrugated iron roofing. The frames are all old, but the roof is new, and has been given two coats of a special red oxide of iron paint. Nearly three-fourths of the piles had to be spliced in order to secure the necessary lengths, which were found to be from 40 feet at the first bent to 71 feet at the outer bent. The piles were "butt spliced" as follows: The butted point of the upper pile (not less than 8 inches in diameter) was placed flat against the butted head of the lower pile and the two were fastened together with four longitudinal iron straps $\frac{3}{4}$ by 3 by 42 inches, bolted through with $\frac{3}{4}$ -inch bolts and banded with two pile rings of $\frac{3}{4}$ by 3 inch iron on the outside of the straps at the junction of the piles. These fastenings were ample after the pile had been hoisted into a vertical position, but on account of the great weight of the jucaró timber and the consequent strain on the splice when the pile was being hoisted into the leads, additional strength was given by spiking on 3 pieces of long leaf yellow pine 3 by 3 inches by 12 feet. This plan of splice had been adopted here by the Obras del Puerto as the result of many years of experience, and it is thought to be the best yet devised. The cost of this splice, including labor and material, is about \$16 per pile.

The scarfed splice was tried, but in hard driving the ends of the scarf would broom and the bolt holes enlarge and the whole splice become loose. It was also found that a butt splice depending only upon the timber cleats spiked or bolted on would not do, as the jar of the hammer would sometimes cause them to split and break loose during the driving. It is very difficult to obtain native piles of greater length than 45 feet, and much delay and increase in the cost of this work was due to the failure of contractors to furnish them.

Sketch of pile splice
Used on Lux pier construction
Scale 1 inch = 1 foot.

Office of Chief Engineer
Division of Cuba.
A. H. Weber
Asst. Engineer

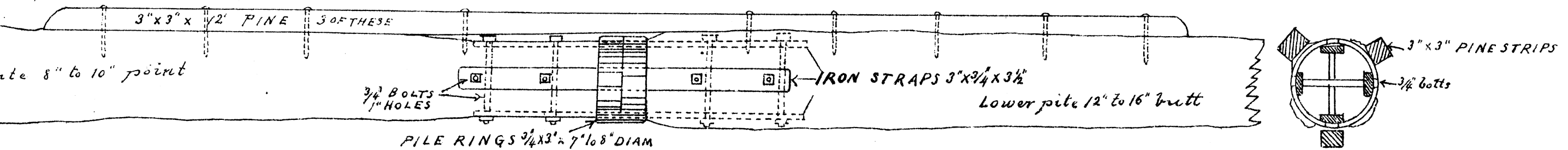


Engineer Department
Division of Cuba
To accompany annual report for fiscal year
ending June 30-1900

M. H. Black
Major Corps of Engineers
Chief Engineer Division of

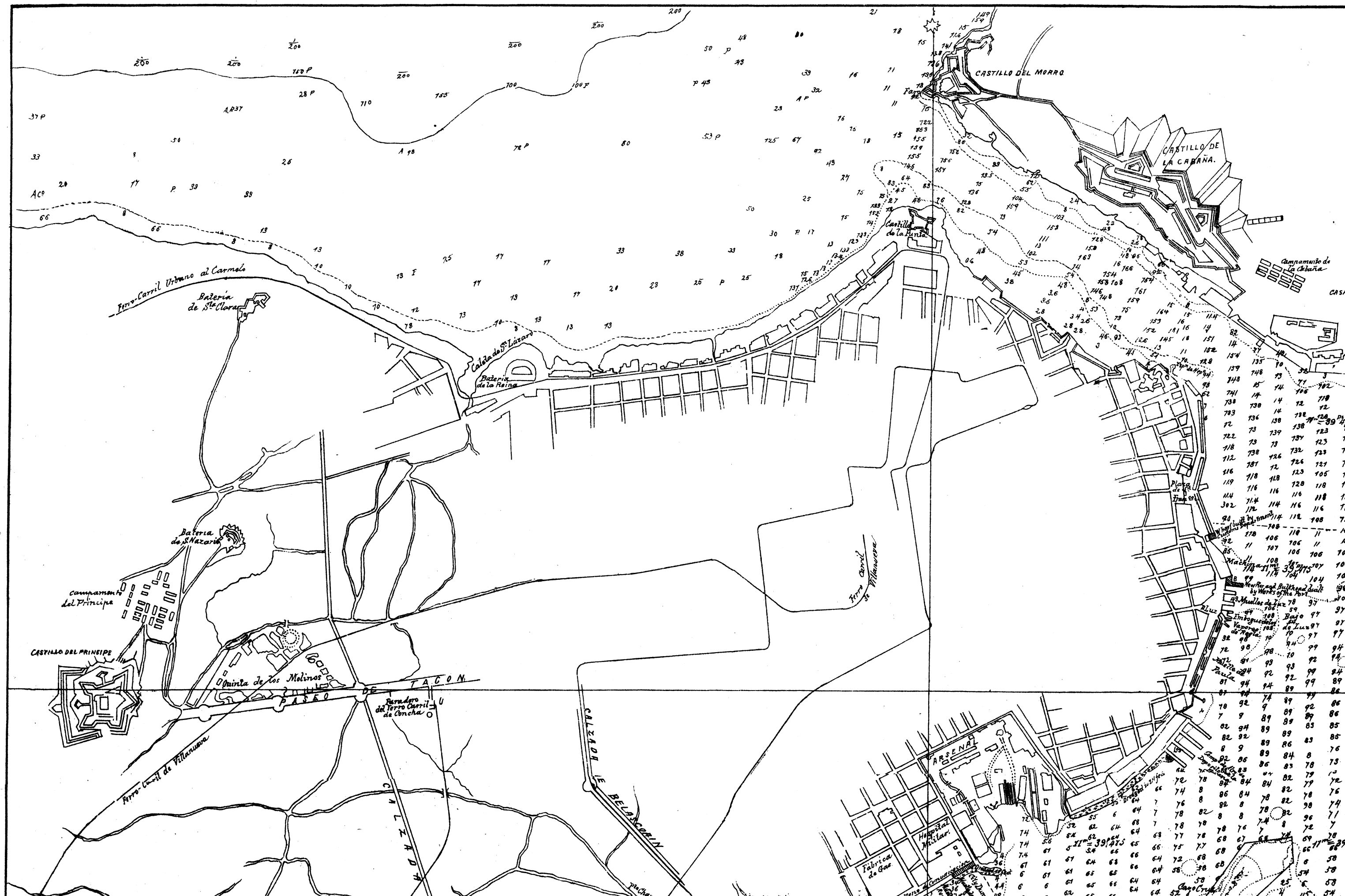
Sketch of pile splice
Used on Luz pier construction
Scale 1 inch = 1 foot.

Office of Chief Engineer
Division of Cuba.
A.H. Weber
Asst. Engineer.




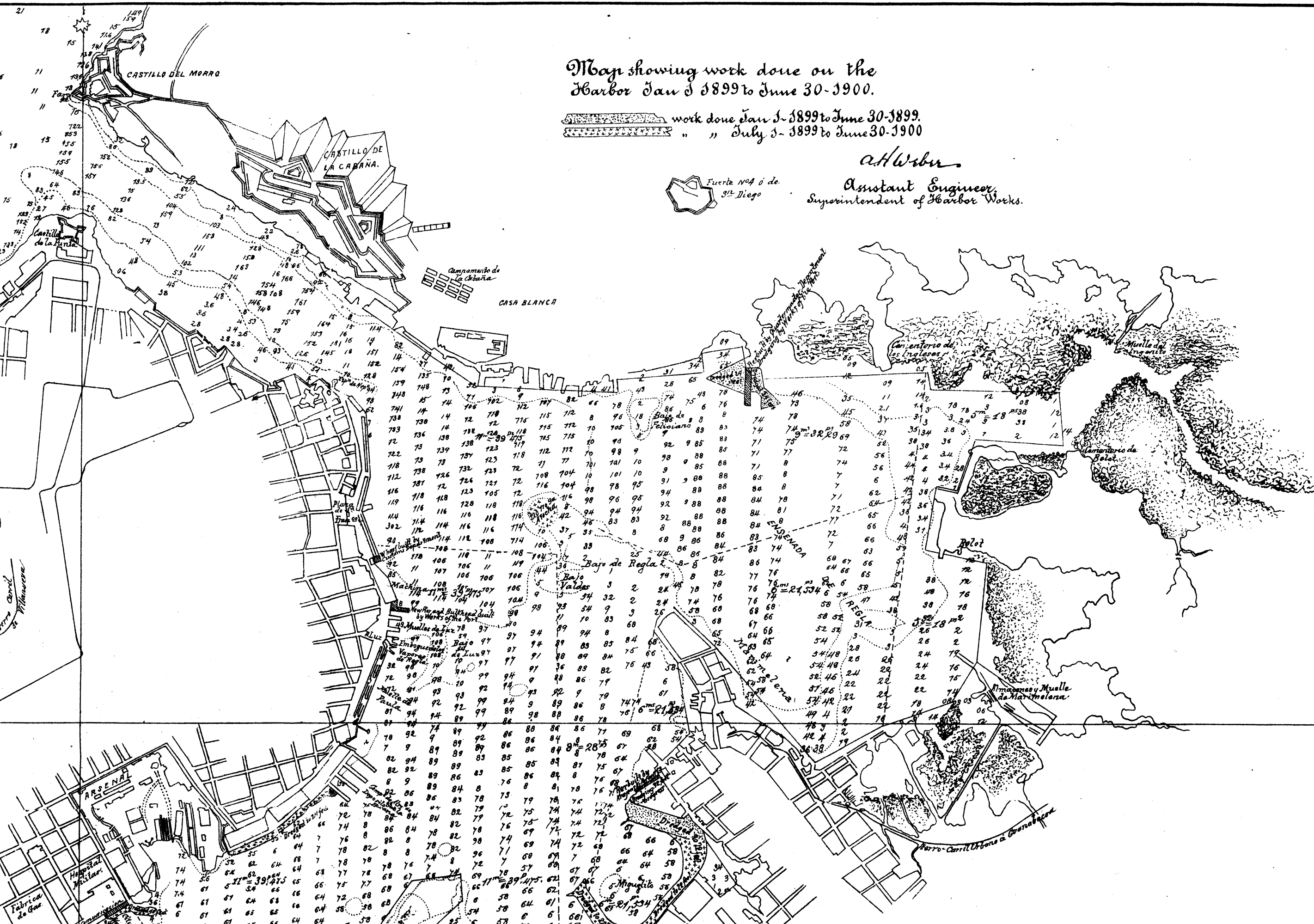
Engineer Department
Division of Cuba
To accompany annual report for fiscal year
ending June 30-1900

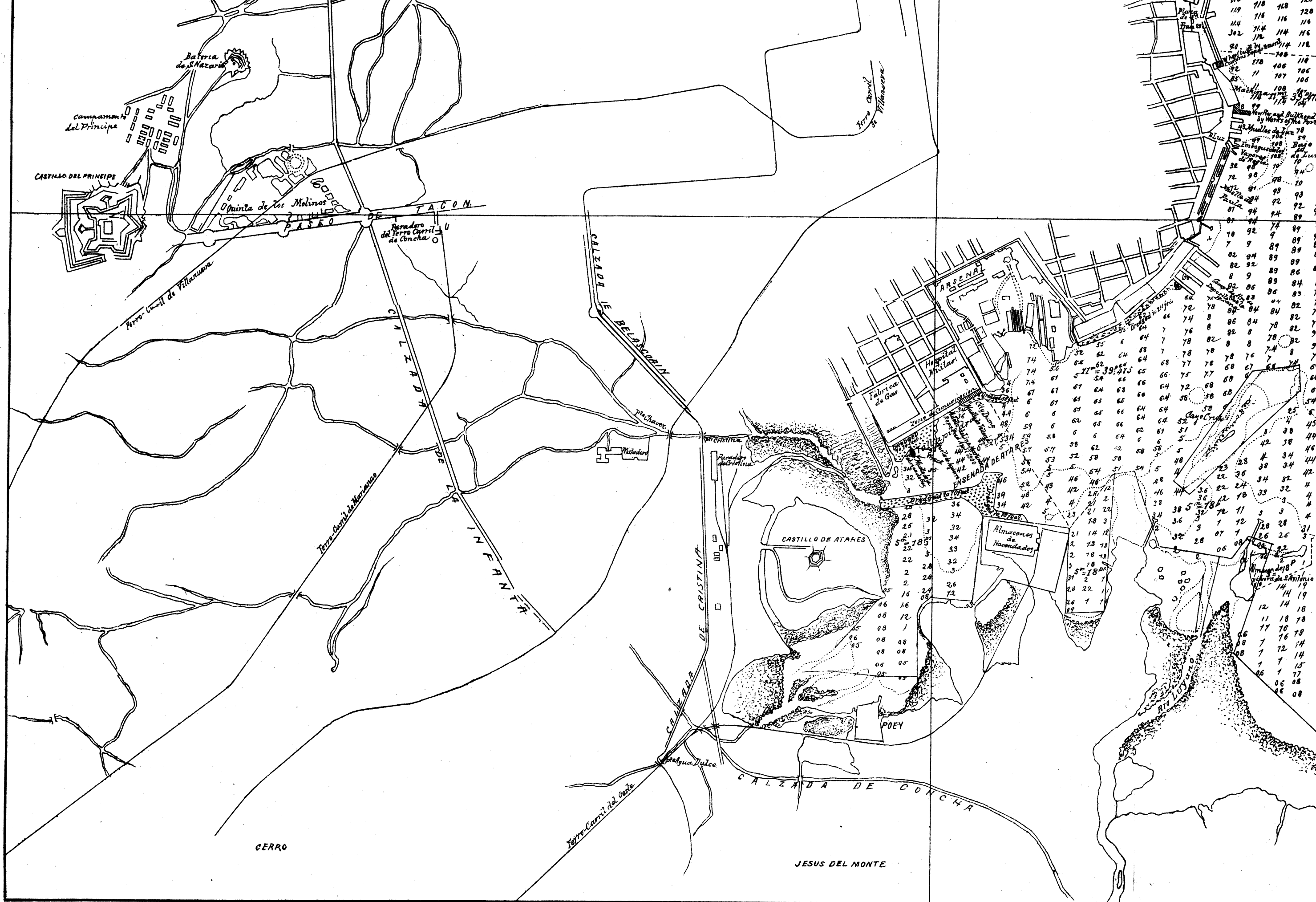
M H Black
Major Corps of Engineers U. S. Army
Chief Engineer Division of Cuba.

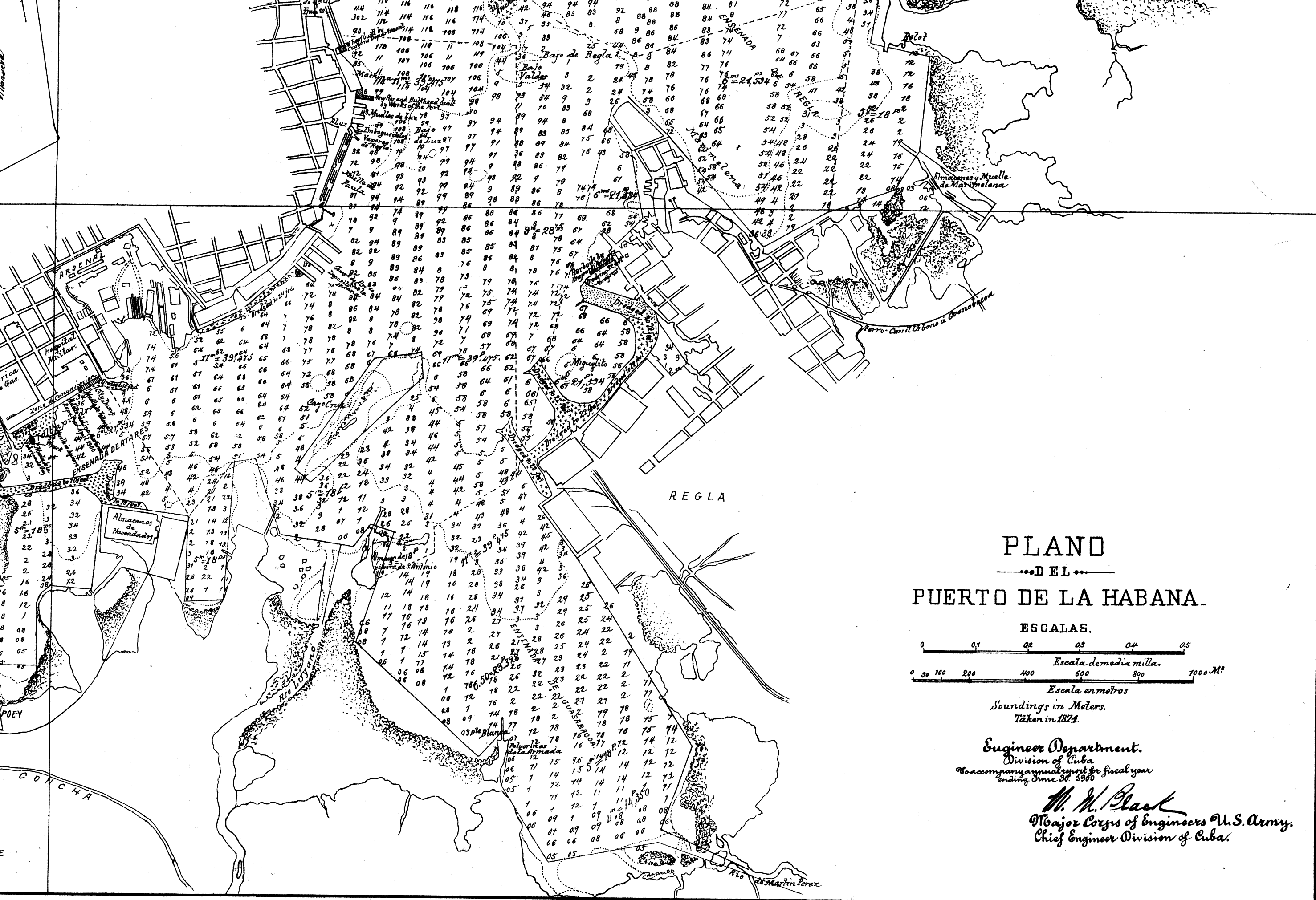


work done Jan 1-1899 to June 30-1899.
" " July 1-1899 to June 30-1900

 Fuerte No. 4 o de
San Diego







PLANO
—DEL—
PUERTO DE LA HABANA.

ESCALAS.

0 0.1 0.2 0.3 0.4 0.5
Escala de media milla.

0 50 100 200 400 600 800 1000 M.
Escala en metros.

Soundings in Meters.
Taken in 1874.

Engineer Department.
Division of Cuba.
To accompany annual report for fiscal year
ending June 30, 1890.

W. H. Black
Major Corps of Engineers U.S. Army.
Chief Engineer Division of Cuba.

Bill of materials and cost.

| | |
|-------------------------------------------------------------|--------------|
| 98 jucaro piles, 1,268 meters, at \$1.856 (average)..... | \$2, 353. 86 |
| 117 miraguano poles, at \$1.30 | 152. 10 |
| 56,481 feet B. M. yellow pine, at \$27.93 (average)..... | 1, 577. 52 |
| 2,800 feet B. M. jucaro lumber, at \$76.428 (average) | 214. 00 |
| 12 barrels nails | 41. 00 |
| 3,993 pounds bolts, spikes, etc., at \$0.068 | 260. 11 |
| 2,644 pounds corrugated roofing, at \$0.048 | 126. 91 |
| 54 gallons natural red oxide paint at \$1.20 | 64. 80 |
| 20 sacks quicklime, at \$0.903 | 18. 66 |
| 11 barrels cement, at \$3 | 33. 00 |
| 3 cubic meters sand, at \$2.753 | 8. 26 |
| 12 wrought-iron pile points, at \$4 | 48. 00 |
| 158 pile rings, at \$2.25 | 355. 50 |
| 362 iron splicing straps, at \$1.70 | 615. 40 |
| 13 mooring rings, at \$8 | 104. 00 |
| 560 cubic meters filling, at \$0.75 | 494. 25 |
| 480 pounds manila rope, at \$0.14 | 67. 20 |
| 100 cubic meters riprap stone, at \$1.30 | 130. 00 |
| Miscellaneous (not classified) | 470. 03 |

Total cost of materials

Total cost of labor, including removal of old shed and pier, pulling old piles, constructing new bulkhead, pier, and shed, splicing piles, filling bulkhead, etc

Total expenditure

Neptuno pier (repairs).—This is a small masonry pier in front of the building of the captain of the port, and was constructed as a break-water for protection to the small craft belonging to the marine medical department and the captain of the port. It was built on a loose stone foundation, with sufficient slope to give it stability, but during or just before the late war about 800 cubic meters of material, including part of the slope of the foundation, were excavated by the Spanish authorities for the purpose of anchoring a torpedo machine. As a result of this work the foundation caved in and a portion of the masonry broke off and toppled into the bay.

Authority for the necessary repairs, with an allotment of \$1,006, was received June 26, 1899. The repairs consisted of removing the stones that had fallen into the bay, driving an underpinning of hardwood piles, which were cut off and capped with heavy timbers below low-water line, and rebuilding the masonry in its former shape. The work was commenced July 1 and completed August 19, 1899.

Expenses incurred:

| | |
|-----------------|-----------|
| Labor | \$709. 06 |
| Materials | 284. 47 |

Total

Bill of material and cost:

| | |
|----------------------------------------------|---------|
| 25 barrels Cuban cement, at \$1.703 | 42. 58 |
| 6½ cubic meters sand, at \$2.537 | 16. 49 |
| 18 jucaro piles, 181 yards, at \$1.400 | 225. 40 |

Total

Lino Martinez wharf (repairs).—At the foot of Revillagigedo street and adjoining the wharves built by the Obras del Puerto is one that formerly belonged to Lino Martinez, but which became the property of the Obras del Puerto in 1895 by virtue of his failing to meet the requirements of the concession compelling him to keep the wharf in a

state of repair. Since the date above mentioned this wharf has not been in use owing to its bad condition. Upon application from a number of lumber merchants who urged a lack of wharf facilities, they were given permission March 27, 1900, to make temporary repairs to this wharf, and in consideration of the private sums expended they are to have the free use of the wharf for a period of seven months. This wharf has a frontage of 15 meters by a width of 20 meters. The old piles were used, some of which were cut off and spliced. Yellow pine was used for the caps, floor timbers, and floor planks. These repairs are of a temporary nature and will not last more than one or two years.

Care and repair of old wharves.—For work under this heading there have been regularly employed 3 wharf keepers, 3 sweepers, 5 carpenters, 1 mason, 4 laborers, 5 sailors, and 1 timekeeper, whose duties are to patrol and keep in repair the public wharves. Materials such as lumber, bolts, nails, paints, piles, etc., are supplied on monthly requisitions, and the work of repair is carried on where most urgently needed. The wharves coming under this head are the general wharves Luz, Paula, and Tallapiedra.

Character and extent of principal repairs.

| | |
|----------------------------------------------------------------------------------------------|--------|
| Piles driven for fenders..... | 21 |
| Piles cut and spliced under wharves at low-water line..... | 66 |
| Mooring rings installed..... | 11 |
| Flooring repaired and renewed.....square meters.. | 757 |
| Floor beams replaced with new..... | 64 |
| Fender posts on land side..... | 11 |
| Pavement repaired and relaid.....square meters.. | 512 |
| Fender border renewed.....meters.. | 97 |
| Column protectors repaired..... | 11 |
| Wooden water-closet constructed..... | 1 |
| Landing steps renewed at Luz and Machina wharves..... | 2 |
| Zinc roofing repaired.....square meters.. | 42 |
| Iron sheds painted at Luz and Paula, two coats outside and one coat inside, square feet..... | 19,562 |

Many minor repairs were made that could not well be classified or measured.

Materials and cost.

| | |
|---------------------------------------------------------------|-----------|
| 19 piles, 252,000 meters, at \$1.9014 each..... | \$497. 16 |
| 16,044 feet yellow pine lumber, at \$27.7867 per 1000..... | 445. 81 |
| 11,467 feet hard wood at \$87.7317 per 1000..... | 1,006. 02 |
| 132 kegs of 6-inch galvanized nails, at \$4.2424 per keg..... | 560. 00 |
| 2,224 pounds bolts and nuts, at \$0.0771 per pound..... | 171. 48 |
| 48 augers and drills, at \$0.7062 each..... | 33. 90 |
| 20 pile head straps, at \$2.25 each..... | 45. 00 |
| 34 paint brushes, at \$0.6285 each..... | 21. 37 |
| 36 cans of paint, at \$1.4416..... | 51. 90 |
| 275 gallons oil, at \$0.60 per gallon..... | 165. 00 |
| 1,001 pounds ochre, at \$0.0303 per pound..... | 30. 40 |
| 1,705 pounds zinc (in sheets) at \$0.0887 per pound..... | 151. 40 |
| 50 pounds solder, at \$0.245 per pound..... | 12. 25 |
| 36 mooring rings, at \$4.0625 each..... | 146. 25 |
| Miscellaneous..... | 268. 46 |

| | |
|------------------------------------------------------|------------|
| | 3,606. 40 |
| Total labor from July 1, 1899, to June 30, 1900..... | 12,363. 93 |

15,970. 33

WHARFAGE.

The wharf line of the city of Habana from the stone pier at the office of the captain of the port to the end of the Muelles de Tallapiedra is 2,663 meters long, divided as follows:

| | Meters. |
|------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| Landing for pilot, post-office and passenger transfer boats | 60 |
| Wharves for general merchandise, Caballeria, Villalta, Aduana Vieja, Carpi- neti, and San Francisco | 593 |
| Machina and navy department | 145 |
| Muelles de Luz, from which project 3 piers, 54 meters, 54 meters, and 50 meters, respectively | 130 |
| Ferry slips operated by Cuban Electric Railroad Company and the United Railroad Company of Habana | 30 |
| Muelles de Paula for coastwise sailing vessels | 280 |
| Unoccupied space | 90 |
| Muelles de San Jose, controlled by private parties under concession from Spanish Government, from which four piers project, each 100 meters | 575 |
| Shore line of arsenal and navy department | 375 |
| Tallapiedra wharf, used for city dump | 83 |
| Tallapiedra wharf, used for unloading lumber | 72 |
| Wharves controlled by private parties | 230 |
| Total | 2,663 |

During busy seasons the available wharfage does not meet the demands, and there seem to be but two methods of increasing the facilities: (1) To construct wharves along the shore line within the limits of the arsenal grounds and convert them for the public service, by which means 550 meters frontage would be secured. The estimated cost of this project is \$60,000. (2) To continue the wharves beyond the gas company property over the low ground about the mouth of Matadero Creek to the Atares hill. This project would require considerable filling back of the wharves, and the dredging of from 300,000 to 500,000 cubic meters. The latter project would have the advantage of greatly improving the sanitary conditions of a part of the city that will always be unhealthy until some such improvements are made. This plan would cost about \$110,000, exclusive of the street filling and approaches. It would provide from 400 to 500 meters additional wharfage.

DREDGING.

Three dredges belong to this department—the *Comercio*, *Puerto Rico*, and *Havana*. One or two of these have been in service almost constantly. It is not possible to utilize all of them at the same time for want of scow and tug service, the number available being 1 tug and 2 wooden and 4 iron dump scows. It would require at least two more scows and another tug to keep all of the dredges busy. Even with two dredges at work in soft material a tug has to be hired to serve one of them.

The principal points at which dredging has been done are: Mouth of Matadero Creek, completing canal; Almacenes de hacendados, channel of approach; Atares Bay, deepening for sanitary purposes; Tallapiedra wharf, completing channel of approach; Regla, basin for Habana Dry Dock Company; wrecked vessel *Atocha*, removing wreck; Regla warehouses, interests of United Railways of Habana, and R. Truffin & Co.; Regla warehouses again, interest of United Railways of Habana; Almacenes de Deposito de la Habana, increasing depth immediately in front of wharf.

Mouth of Matadero Creek.—The dredging of a canal 60 feet wide and 10 feet deep through the foul deposits at the mouth of this creek,

connecting it with deep water in the bay, was fully described in report for fiscal year ending June 30, 1899, in which it was stated that the work was nearing completion. The dredge *Comercio* continued until July 3, and the *Puerto Rico* until the 16th, when the work was finished. During this period 3,900 cubic meters were dredged and transported to sea at a cost of \$873.91, an average of \$0.224 per meter. The total quantity excavated on this work was 33,332 cubic meters, at an average cost of \$0.183 per meter.

Empresa de Almacenes de Hacendados de la Habana.—These warehouses are located at the upper end of the harbor, in what is known as Atares Bay. A channel of approach to and alongside of these warehouses was dredged at the request of the owners, in letter dated August 14, 1899, and on recommendation of Assistant Engineer A. H. Weber, in report dated August 19, 1899, authority for the work being contained in 3d, 4th, and 5th indorsements, dated August 26, 28, and 30, respectively, on original letter from the company. The authorization provides that the harbor in this vicinity be dredged to an average depth of 10 feet at the public expense, and that a channel be dredged in front of the warehouses above referred to, provided the company pay the entire expenses of all work below a depth of 10 feet. An estimate was furnished the company as follows: To open a channel 18 feet deep and 90 feet wide to and along the front of the warehouses, 45,000 cubic meters of material, at 15 cents, \$6,750. The company was requested to make a deposit of this amount, but they furnished only \$1,000, with which sum the work was begun and continued until the funds were exhausted. A small portion of the work was at a depth of less than 10 feet, and this was done at public expense.

The *Comercio* and *Puerto Rico* were employed on this, and the *Cristina* towed the scows to sea. Work began August 31 and was completed September 24.

Work performed:

| | |
|-------------------------------------------------------------------------------|----------|
| <i>Comercio</i> , August 31 to September 16.....cubic meters.. | 10,800 |
| <i>Puerto Rico</i> , September 22 to 24.....do..... | 550 |
| | <hr/> |
| | 11,350 |
| Transported to sea.....cubic meters.. | 11,350 |
| Amount above 10 feet in depth.....do..... | 1,800 |
| Amount below 10 feet in depth.....do..... | 9,550 |
| | <hr/> |
| Cost of labor..... | \$864.78 |
| Cost of materials and repairs..... | 332.42 |
| | <hr/> |
| | 1,197.20 |
| Cost per cubic meter..... | .105 |
| Proportion charged to warehouse company, 9,550 cubic meters, at \$0.105 | 1,000.00 |

Atares Bay.—Under the authority just mentioned, dredging to a depth of 10 feet was carried on by the *Puerto Rico* near the mouth of the canal connecting Matadero Creek with deep water in Altares Bay, September 25 to November 22, 1899, when it was suspended on account of urgent demand for the dredge elsewhere.

Work performed:

| | |
|---------------------------------------------------------------------------|------------|
| <i>Puerto Rico</i> , September 25 to November 22, 1899.....cubic meters.. | 11,350 |
| <i>Cristina</i> towed to sea.....do..... | 11,350 |
| | <hr/> |
| Cost of labor and superintendence..... | \$2,232.52 |
| Cost of materials and repairs..... | 916.25 |
| | <hr/> |
| | 3,148.77 |
| Cost per cubic meter..... | .277 |

High winds prevailed during a period of twelve days while this work was in progress, preventing the towing of scows to sea, to which circumstance the unusually high cost is due. Dredging was again started in Altares Bay on April 19, 1900, with the dredges *Havana* and *Puerto Rico*, at a point immediately in front of the bulkhead of the gas works company. The purpose of this work is twofold, the deepening of the bay to effect better sanitary conditions, and at the same time to open a channel to the bulkhead by means of which the congested condition at the lumber wharves will be somewhat relieved. This work was suspended June 8, 1900, the dredges being needed for more urgent purposes.

Work performed:

Excavated by dredge—

| | | |
|--------------------------|----------------|---------------------|
| <i>Havana</i> | cubic meters.. | 8, 857 |
| <i>Puerto Rico</i> | do..... | 8, 826 |
| | | <hr/> 17, 680 <hr/> |

Transported to sea by—

| | | |
|-----------------------|----------------|---------------------|
| Hired tug | cubic meters.. | 13, 198 |
| <i>Chlio</i> | do..... | 3, 292 |
| <i>Cristina</i> | do..... | 1, 200 |
| | | <hr/> 17, 680 <hr/> |

Expenses incurred:

| | |
|---------------------------------|--------------|
| Labor and superintendence | \$2, 033. 57 |
| Material and repairs | 441. 38 |
| Tug hire | 1, 155. 00 |
| <i>Chlio</i> | 292. 00 |
| <i>Cristina</i> | 68. 00 |

| | |
|----------------------------|------------|
| Total | 3, 989. 95 |
| Cost per cubic meter | . 225 |

Regla, Basin for Havana Dry Dock Company.—Under date of November 18, 1899, Krajewski Pesant Company, of Habana, made application for the dredging of a basin for the installation of a floating dry dock at Regla, authority for the construction of which had previously been given. A project and estimate of cost were submitted December 11, 1896, recommending that this department be authorized to execute the work on condition that Krajewski Pesant Company pay all expenses of same. The estimate of quantity and cost was as follows:

| | |
|-------------------------------------------------------------------------|----------|
| Soft material, 16,000 cubic meters, at 25 cents | \$4, 000 |
| Hard material requiring blasting, 20,500 cubic meters at 60 cents | 12, 300 |

| | |
|-------------|---------|
| Total | 16, 300 |
|-------------|---------|

The project was approved by the department commander December 16, 1899. On account of the insufficient data regarding the character of the material to be dredged and the obstructions lying within the outline of the project, such as old piles, sunken boat wreckage, etc., the estimate of cost is but an approximation and may be materially increased.

This work was started February 8, 1900, and excepting the period April 19 to June 1, when it was temporarily suspended pending the arrival of a steam drilling plant, has continued to date. The dredge *Havana* was employed February 8 to April 19, and on June 30. The *Puerto Rico* was employed March 19 to April 19 and from June 16 to date. During this period the *Havana* had a double crew from March 19 to April 19, and the *Puerto Rico* from March 21 to April 19.

In addition to the quantity of ordinary material dredged, there have been removed, by pulling or blasting, 55 piles, 20 large timbers, and a miscellaneous lot of miraguano poles, planks, old iron, etc., which work was too heavy for these dredges and resulted in injury to the buckets and machinery, retarding the progress of the work and increasing its cost.

The steam drill, a full description of which is given under the head of "Plant," was put in commission on this work June 1, and with minor interruptions has continued steadily to date. This machine is a great improvement over the old hand-power machine formerly used. During the month the average depth drilled per working day was 48 feet, as against about 5 feet with the hand driller. The labor employed is the same as on the hand drill, and the only additional cost per day is about \$3 for fuel, and smith work in sharpening the drills and making repairs. The material drilled has been principally stone, but in some instances argillaceous clay and sand were found to a depth of 12 feet, although the hole was but 10 feet from one that passed through solid stone.

The depth to be attained in this work is 32 feet and the depth to be drilled and blasted is from 10 to 18 feet. The holes are placed 10 feet apart each way and are drilled to a depth of about 4 meters each and then blasted. It has been found from experience that after a drill hole has been carried down 10 to 12 feet it begins to accumulate mud and rock chippings, the force of the jet being insufficient to keep it clean. On this account it will be necessary to go over a portion of the work a second time to obtain the full depth required.

Work performed:

| | | |
|---------------------------------|----------------|----------------|
| Dredge <i>Havana</i> | cubic meters.. | 8, 125 |
| Dredge <i>Puerto Rico</i> | do..... | 5, 327 |
| | | <u>13, 452</u> |

| | |
|--------------------------------------|------------------|
| Transported to sea | 13, 452 |
| Holes drilled and blasted | 91 |
| Total depth drilled..... | meters.. 371. 28 |
| Average depth of hole..... | do..... 4. 08 |
| Average charge of dynamite used..... | pounds.. 5. 94 |

Expenses incurred.

| | Labor. | Material. | Total. |
|-------------------------------------------------------|--------------|-----------|-------------------|
| Puerto Rico | \$1, 056. 60 | \$135. 10 | \$1, 191. 70 |
| Havana | 1, 683. 93 | 220. 70 | 1, 904. 63 |
| Driller..... | 426. 86 | 65. 65 | 492. 51 |
| Clio | | | 36. 00 |
| Hired tug | | | 1, 190. 00 |
| Charge for service and wear and tear of dredges | | | 924. 00 |
| Office and superintendence expenses | | | 432. 50 |
| Miscellaneous, powder, lights, fuse, etc..... | | | 516. 28 |
| Total | | | <u>6, 687. 62</u> |

Cost per cubic meter, \$0. 4971.

Tallapiedra wharf.—The dredging at this point was nearing completion at the close of the fiscal year ending June 30, 1899, and is described in report for that date. The work that remained to be done was the dredging of that portion immediately adjoining the new bulkhead, and the material consisted principally of the wreck of an old wharf and a

pile of stone and other débris that had been thrown in from the navy-yard. This part of the work was consequently very expensive, and in order to give a true idea of the cost of the project as a whole, the result of what was done during the present fiscal year will be given, and also the results of the whole work. Work performed July 1 to July 27, excavated 1,827 cubic meters, at \$0.51, \$932.70; total work performed June 2 to July 27, excavated 10,222 cubic meters, at \$0.191, \$1,957.78.

Wrecked vessel Atocha.—This was a Spanish war vessel of 40 guns, built in the port of Habana in 1789. On July 2, 1816, she was burned and sunk while lying at anchor in about 25 feet of water. This occurred at a point approximately in the center of a triangle formed by lines connecting the Machina, Almacenes de Santa Catalina, and the crane at the Casa Blanca shops. The jagged edges of the sides and ends were about 16 feet below the surface of the water, making the wreck an obstruction to navigation, the site having been marked by a buoy for many years. Under verbal instructions the work of removing the wreck was commenced with the dredge *Havana*, August 30, 1899, and was completed January 6, 1900. The presence of the obstruction had caused a deposit in and around the hull, which completely covered it. This sediment was dredged to a depth of 26 to 30 feet, which conforms to the average depth in this vicinity. The timbers and planking of the sides and end were either blasted or torn off, a diver being employed to place the explosives or attach the chains. The depth attained was thought sufficient for the deepest draft vessels entering this port and the bottom timbers were not removed, as this would have required several months, and an additional expenditure of about \$2,000. In connection with the dredging a number of brass and iron cannons and a miscellaneous lot of shot, lead, pig-iron ballast, brass, and copper were removed.

Materials removed:

| | | |
|-----------------------------------------------------------|----------------|--------|
| Sediment dredged | cubic meters.. | 1, 151 |
| Timbers and planking removed | do..... | 174 |
| Iron and brass cannons | | 34 |
| Iron ballast, cannon balls, lead, chains, hooks, etc..... | tons.. | 16 |

Expenses incurred:

| | |
|-------------------------------------------------------------|--------------|
| <i>Havana</i> , labor, \$2,074.38; materials, \$672.78..... | \$2, 747. 16 |
| <i>Cristina</i> , labor, \$269.48; materials, \$214.13..... | 483. 61 |

| | |
|-----------------|------------|
| Total cost..... | 3, 230. 77 |
|-----------------|------------|

Regla warehouses.—Application was made by the United Railway Company of Habana May 26, 1899, to have certain dredging done at their wharves at Regla, they agreeing to pay all expenses attached to the work. A project and estimate was submitted June 24, 1899, and approved by the department commander June 28, 1899. The project contemplated the dredging of a channel to and alongside the eastern end of the wharves to a depth of 18 to 20 feet and a width of 90 feet; also a channel to and in front of the western end of the wharves to a depth of 22 feet. The estimate of quantity and cost was 26,880 cubic meters, at \$0.18, \$4,838.40. Work was commenced July 3, 1899, with the dredge *Comercio*, which continued to August 30, 1899. The dredge *Havana* was utilized August 15 to 24, and 27 to 29. The tug *Cristina* towed the scows to sea from July 3 to August 7 and August 14 to 30. A tug was hired during the period the *Cristina* was laid up for repairs. The channel of approach to the west

end passed near the wharf of R. Truffin & Co., of Regla, and that firm requested that the work be extended at their expense so as to complete a good channel to their wharf. The estimated cost of this additional work was \$400, which sum was deposited August 21, and expended in broadening the channel immediately in front of their wharf. The desired depth of 18 feet was fully attained in the east end of the channel, but in the 22-foot channel at the west end a small portion, where the material was pure stone requiring blasting, was left at a depth of 20 feet. The work was completed August 30, 1899.

Work performed:

| | | |
|------------------------------------------------------------|----------------|------------|
| Dredge <i>Comercio</i> July 3 to August 30 | cubic meters.. | 34,500 |
| Dredge <i>Havana</i> August 15 to 24 and 27 to 29 | do..... | 1,664 |
| | | 36,164 |
| Transported to sea by <i>Christina</i> and hired tug | | 36,164 |
| Expenses incurred: | | |
| <i>Comercio</i> — | | |
| Labor | \$1,670.10 | |
| Materials | 1,443.71 | |
| | | \$3,113.81 |
| <i>Havana</i> — | | |
| Labor | 158.09 | |
| Materials | 33.65 | |
| | | 191.74 |
| <i>Cristina</i> — | | |
| Labor | 538.97 | |
| Materials | 361.88 | |
| | | 900.85 |
| Office and superintendence | | 600.00 |
| Hired tug towing scows | | 432.00 |
| | | 5,238.40 |
| Cost per cubic meter | | \$0.1445 |
| Paid by United Railway Company | | 4,888.40 |
| Paid by R. Truffin & Co | | 400.00 |
| | | 5,288.40 |

On October 24, 1899, the general manager of the United Railway Company of Habana made further application for dredging, to include all of the wharf frontage, with the necessary approaches, that had not been covered by previous work, the railroad company to pay all expenses, as usual.

A project was submitted November 16, 1899, which provided for a central channel of approach 50 meters in width, branching in front of the ferry slip and extending from this point along the wharf in both directions, the width of this portion to be 30 meters, the depth of the whole to be 22 feet. This project was forwarded to headquarters November 20 and approved by the department commander November 23, 1899.

Work was started December 17, 1899, with the dredge *Comercio*, the tug *Cristina* serving as a tender in towing scows to sea, and continued, with no serious interruptions, except the loss of time due to windy weather, which prevented the scows being towed to sea, until May 30, 1900, when the *Comercio* and *Cristina* were laid up for repairs.

A small portion of the dredging close to the wharf required drilling and blasting. This work was started with the old hand driller and continued with the steam driller during May, 1900. Twenty-seven

holes were drilled to an average depth of 1.75 meters and charged with 4 pounds of dynamite each. About 500 cubic meters of stone were loosened. The clam-shell dredge *Puerto Rico* started removing this stone June 2, with a hired tug as tender, and completed it June 15. There still remain from 1 to 3 feet to be removed from a small area.

Work performed:

Material excavated by—

| | | |
|--------------------------|----------------|--------------------|
| <i>Comercio</i> | cubic meters.. | 71,665 |
| <i>Puerto Rico</i> | do..... | 532 |
| | | <hr/> 72,197 <hr/> |

Transported to sea by—

| | | |
|-----------------------|---------|--------------------|
| <i>Cristina</i> | do..... | 71,665 |
| <i>Clio</i> | do..... | 66 |
| Hired tug | do..... | 466 |
| | | <hr/> 72,197 <hr/> |

Expenses incurred:

Comercio—

| | | |
|-----------------|------------|------------|
| Labor | \$4,599.04 | |
| Materials | 1,115.85 | |
| | <hr/> | \$5,714.89 |

Puerto Rico—

| | | |
|-----------------|--------|--------|
| Labor | 103.00 | |
| Materials | 35.00 | |
| | <hr/> | 138.00 |

Cristina—

| | | |
|-----------------|----------|----------|
| Labor | 1,632.41 | |
| Materials | 472.29 | |
| | <hr/> | 2,104.70 |

| | |
|--------------------------------------|----------|
| <i>Clio</i> , no division made | 4.00 |
| Office and superintendence | 1,626.67 |
| Drillers | 550.00 |
| Hired tug | 49.00 |
| Miscellaneous | 121.35 |
| | <hr/> |

10,308.61

Cost per cubic meter \$0.142

Almacenes de deposito de la Habana.—Application for certain dredging was made by the manager of the almacenes de deposito de la Habana (better known as the San Jose wharves), and approved by the department commander in indorsement dated March 20, 1900 (O. C. E., file No. 9313), under the usual terms of the beneficiary paying all expenses attached to the work. The project contemplated the removal of a number of humps or shoals immediately in front of the wharf, which prevented large vessels from lying alongside. Work was started with the dredge *Havana* June 8, 1900, and continued steadily until June 28, on which date the funds were exhausted and the work discontinued. A hired tug in connection with the Department tug *Clio* was used in transporting the material to sea.

Work performed:

| | | |
|-----------------------------------|----------------|-------|
| Material excavated | cubic meters.. | 3,400 |
| Material transported to sea | do..... | 3,400 |

Expenses incurred:

| | |
|-------------------------------------|----------|
| Labor and superintendence | \$290.00 |
| Materials and current repairs | 121.00 |
| Towing scows to sea | 199.00 |
| | <hr/> |

Total 610.00

Average cost per cubic meter 0.1790

General summary of capacity and cost of dredges.

[Average cost and capacity per day for total period employed, including Sundays, holidays, time lost through bad weather, and while making current repairs.]

| | Labor. | Material and repairs. | Total. | Work per day, cu. mtrs. | Cost per cu. mtr. |
|-------------------|---------|-----------------------------|---------|-------------------------------|----------------------|
| Comercio | \$27.53 | \$15.93 | \$43.46 | 509 | \$0.099 |
| Havana | 19.06 | 7.41 | 26.47 | 126 | .21 |
| Puerto Rico | 17.26 | 8.82 | 26.08 | 145 | .18 |

Average cost and capacity per day for actual working days:

| | | |
|---------------------------------------------|-------------------|--------|
| <i>Comercio</i> , 667 cubic meters | per cubic meter.. | \$0.07 |
| <i>Havana</i> , 185 cubic meters | do..... | .14 |
| <i>Puerto Rico</i> , 224 cubic meters | do..... | .11 |

Average cost of transporting material to sea:

| | |
|--------------------------------------|-----|
| Average cost per cubic meter by— | |
| Department tug <i>Cristina</i> | .04 |
| Hired tug | .10 |

NOTE.—The results obtained by the *Puerto Rico* and *Havana* are below their actual capacity, owing to the fact that much of their time was occupied by pulling such wreckage as old piles, timbers, garbage from sunken scows, iron ballast, cannons, etc., in addition to actual dredging.

Summary of dredging during fiscal year 1899–1900.—Total quantity dredged, 172,473 C. M. Total cost of dredging, including transportation to sea, \$32,218.15. Average cost of dredging, per cubic meter, \$0.1868.

MISCELLANEOUS.

Under this heading will be described: Extending sewer at Machina passenger landing, cleaning harbor front, raising and repairing tug *Catalina*, cleaning Matadero Creek, Cabaña, tide gauges, and borings.

Extending sewer at Machina passenger landing.—One of the largest sewers in Habana, 4 feet 6 inches by 4 feet 6 inches, emptied through the stone bulkhead under San Francisco wharf, at a point about 50 feet from the general passenger landing at Machina. This wharf is 90 feet wide, and the close spacing of the piles prevents sufficient flow of the currents to carry away the unceasing flow of filth. As a result, a deposit had accumulated at this point almost to the water surface, from which foul odors emanated to greet incoming passengers and threaten the health of those in the vicinity. To overcome this nuisance it was decided to extend the sewer to the outer edge of the wharf, where the unobstructed current would carry the filth away. The work was commenced July 19, and finished August 16, 1899. The plan pursued was to construct a heavy yellow-pine sluice box 4 feet 6 inches by 4 feet 6 inches by 90 feet long, well banded with 4 by 4 inch yellow pine. The box was made on the edge of the wharf, and when completed was tipped into the bay and floated under the wharf, where it was loaded with stone and sunk into position, the inner end coming flush with the sewer outlet and the outer end being held by braces at a depth of 10 feet under water. The whole box was then fastened to the piles and to the girders above with 4 by 6 inch yellow-pine braces. The joint between the box and the bulkhead was then cemented. This was effected by the service of divers. From the moment the flow began to discharge through this new outlet the odor ceased. During this work it was necessary to dredge by hand some

30 cubic meters of deposit and to remove 7 old piles that were in the way. The cost of this work was paid by the sewer department.

Expenses incurred:

| | |
|-----------------|-----------|
| Labor | \$574. 75 |
| Materials | 494. 64 |

1, 069. 39

The greatest care was taken to preserve the health of those engaged in this dangerous piece of work, 1,661 pounds of chloride of lime, 20 sacks of quicklime, and about 9,000 gallons of electrozone were used, and notwithstanding the fears and warnings of those in the neighborhood regarding the dire effects of this work, not a case of sickness resulted.

Cleaning harbor front.—A crew of 1 foreman and 8 men, with a large rowboat capable of carrying about 2 tons, have been regularly employed to patrol the harbor front, from La Punta to Matadero Creek and gather up all refuse deposited on the shore. With each ebb tide and shoreward wind there are deposited bits of lumber, old boxes, decayed vegetable matter, dead dogs and cats, etc., which in a short time would create a stench and finally disease if not collected and carried away. From two to three complete trips are made each week, the refuse being deposited in the dump of garbage scows and taken to sea. This work has recently been extended to include Matadero Creek from its mouth to the aqueduct just above the slaughterhouses. Expenses incurred, labor, \$3,076.50.

Raising and repairing tug Catalina.—On the morning of November 8, 1899, the tug *Catalina*, owned by Jose Cagigas, while approaching San Francisco wharf with a lighter in tow, collided with the tug *Deulofeu*, owned by the engineer (street) department, headed toward the entrance of the harbor. The bow of the *Deulofeu* struck the *Catalina* just forward of the cabin on the port side, breaking through the side from the deck down to about 3 feet below the water line, resulting in her sinking in about five minutes in 40 feet of water, the crew seeking safety on the lighter. An investigation and trial were held by the captain of the port for the placing of the responsibility for the accident. His decision placed the responsibility for the accident and the cost of raising and repairing the *Catalina* upon the master of the *Deulofeu*. The work of raising and repairing her was assigned to the department of the works of the port, and was begun November 20, 1899. An examination showed that she lay in 40 feet of water, right side up, but slightly inclined to port. Two barges, each about 25 by 100 feet, were secured, and on one of these two hoisting engines were installed. The barges were spread 22 feet apart and bridged between, near bow and stern, with 12 long timbers, 6 at each end. On these timbers heavy sheaves were arranged so that chains might be passed under the bow and stern of the tug and lead through the sheaves to pulling tackle on deck. These lifting chains, as well as the pulling blocks, were the heaviest that could be secured here. One set of the heavy blocks was attached to each end of the chains, and a luff, consisting of a moderate-sized set of blocks and falls, was placed so as to pull on the heavy fall lines. The falls of these latter blocks led on one barge to the hoisting engines, and on the other to the engines of two floating pile drivers which were moored to the barge, end on. This

collection and arrangement of rigging occupied the crew until December 1, 1899, when the plant was towed to the sunken boat and the chains placed in position by divers. The operation of raising her would now have been quick and simple, but the chain at one end was old, and when she was but fairly started, it parted. This occurred again the next day, and a new chain, the best that was procurable, was purchased, and this also broke twice, but finally, on December 7, she was brought to the surface and floated to the marine railway at Regla and docked, and a thorough examination of her condition made. Upon request, the captain of the port directed his inspector of hulls and boilers to confer with the representatives of the engineer department from time to time and to inspect and direct the repairs, in order that everything should be done in accordance with the laws and regulations governing shipbuilding and to the full extent required by his decision.

Worked performed in repairs.—The following is a brief description of the work done: The copper was stripped off from the upper edge down to the second plank below the damaged portion and extending sufficiently far toward the bow and stern to expose the butts of all injured planks. All broken planks of the side, ceiling, deck ribs, and deck timbers were removed to the old butts and were replaced with the best material obtainable, native hard wood being used for the ribs and knees, and long-leaf yellow pine for the sides and deck. Various small repairs, such as shelving, hanging of doors, repairs to lockers, skylights, etc., were made to the cabin, which was no doubt in bad condition when she sank, but as it was impossible to determine what part of these repairs became necessary on account of the accident, the owner was given the benefit of the doubt and the whole was done. The boiler, engine, and hull were completely overhauled by an engineer, all packing and joints renewed, a complete new covering of asbestos put on the boiler, and three new pressure gauges were supplied to replace the old ones. The cabin, hull, and smokestack were scraped and given a new coat of paint. The compass was sent to an instrument maker, who took it apart and thoroughly cleaned and repaired it. These repairs, etc., were all completed January 17, 1900.

Expenses incurred:

Obras del puerto (raising)—

| | | |
|----------------------------------------------------|-----------|-----------|
| Labor (regular employees, works of the port) | \$977. 60 | |
| Materials purchased..... | 10. 91 | |
| | | \$988. 51 |

Paid by department of streets—

| | | |
|--------------------------------------|------------|------------|
| Labor (additional employees)..... | 286. 00 | |
| Materials purchased and rented | 1, 254. 99 | |
| | | 1, 540. 99 |

| | | |
|-----------------------------------------------------|------------|------------|
| Total | | 2, 529. 50 |
| Repairing hull (by contract) | 2, 423. 00 | |
| Overhauling machinery, painting, and repairing..... | 609. 04 | |
| | | 3, 032. 04 |

| | | |
|-------------|--|------------|
| Total | | 5, 561. 54 |
|-------------|--|------------|

A considerable quantity of the materials purchased for use in raising, consisting of ropes, chains, timbers, etc., are practically uninjured and can be utilized by the department, thus saving the purchase of new.

| | |
|-----------------------------------------------------------------------------|------------|
| The estimated value of this material is | \$909. 00 |
| Actual cost of work, deducting value of materials that can be used again .. | 4, 661. 54 |

PLANT.

The plant belonging to this department consists of 3 dredges, *Comercio*, *Havana*, and *Puerto Rico*; 2 tugs, *Olio* and *Cristina*; 5 iron dump scows (one of which is in the service of the street department), 2 wooden dump scows, 2 floating pile drivers, 1 steam drill, operated from a pile driver hull, and several rowboats. The *Olio* was purchased during the fiscal year ending June 30, 1899, and the steam drill during the present fiscal year; all other plant belonged to the obras del puerto when the American authorities took control of the island.

The *Comercio*, a dredge of the endless chain bucket type, is an excellent machine of about 800 cubic meters daily capacity. She had been in service six years without any extensive repairs, although under the Spanish régime the engineer director of the obras del puerto reported that expensive repairs were necessary. On September 16 the bow winches gave way completely, necessitating her laying up. A project for the systematic repair of her machinery was submitted September 19, 1899, at an estimated cost of \$6,500, which sum was allotted in the October allotment. The work of repair was begun as soon as proposals could be secured, and continued until December 11, when the most urgent work was completed and the dredge was again put in commission. From this date the repairs were carried on from time to time without interfering with the operations of the dredge until the latter part of May, 1900, when it became necessary to dry dock and lay her up for a month to complete such work as could not be carried on while she was in service. All important work has now been done and she will be ready for service early in July. The total allotment has been expended.

Tug Cristina.—This tug belongs to the obras del puerto and is a first-class boat. She has been in service over six years, and her machinery needed a general overhauling. Authority for the necessary work, contained in division file 2539, O. C. E. file 00217, not to exceed \$1,700, was received May 25, 1900, and the work of repair begun June 2, and is now well advanced and will probably be completed about July 15. Liabilities for all the repairs, \$1,700.

Tug Olio.—The tug *Olio* has been used for the general service of the Department of Habana, making regular trips between Habana and Morro and Casa Blanca, for the transportation of troops, workmen, and materials. She has also been used for the transportation of materials pertaining to any branch of the engineer department, and during the past two months has been towing dredged material to sea. The following extensive repairs were made on the *Olio*: July, 1899, new condenser in place, \$1,275; March, 1900, new Scotch marine boiler, \$3,468; April, 1900, installation of boiler with other small repairs and modifications, \$1,532; total, \$6,275.

Iron dump scows.—These boats have been in service since 1893, and the constant wear of the dredged material on the sloping sides of the hoppers, and the natural wear due to corrosion, had worn the inner lining of the hoppers to such an extent that many of them leaked, and often, in working in hard substances, the weight of the material would break through the weakened metal. Authority to make the necessary repairs was given by the department commander June 6, 1899. The plan proposed was to put an entire new sheet of iron 4 feet wide completely around the inside of the boats, and to renew as much of the

deck as was in bad condition. One scow was repaired at a time (so as not to interfere with the operation of the dredges), beginning in July, 1899, and continuing until February, 1900.

Expenses incurred:

| | |
|-------------|---------|
| Scow A..... | \$1,400 |
| Scow B..... | 1,400 |
| Scow C..... | 1,240 |
| Scow D..... | 1,150 |
| Scow E..... | 1,217 |

6,407

None of the other plant had more than ordinary repairs.

Steam drill.—A steam drill for use in connection with submarine rock excavation to take the place of the crude hand-power machine belonging to the obras del puerto was purchased in April, 1900. In rigging up this plant one of the floating pile drivers of the department, fitted with boiler and hoisting engine, was utilized. In order to have ample boiler power, another upright tubular boiler of 12 horsepower nominal capacity, which was on hand, was installed with its feed pump, thus making a total capacity of about 25 horsepower. There was also installed one small single-action pump $\frac{3}{4}$ -inch discharge, to furnish a stream of water through $\frac{1}{2}$ -inch rubber hose and $\frac{1}{4}$ -inch iron pipe, to keep bore holes free of clippings. For this purpose the iron pipe is let down the bore hole alongside the drill steel and a constant stream of water is made to play into the bottom of the hole while the drill is at work, thus keeping the bit clear of the rock clippings. Anticipating that the stream from this small pump would prove ineffectual in attempting to work the drill through the compact tenacious blue clay found in other parts of the harbor, a larger duplex pump, 2-inch discharge, 3-inch suction, was installed, and will be tried when occasion requires. The steam pipe connections are so arranged that either boiler can be made to run either the hoisting engine, steam drill, or any of the pumps. The steam drill used is an Ingersoll automatic feed drill, C size, $4\frac{1}{4}$ -inch steam cylinder.

Instead of the customary mounting, consisting of bolting the shell of the drill by means of the back bolt to a tripod, it was bolted to the 2,200-pound hammer of the pile driver, which had a $1\frac{1}{4}$ -inch hole drilled through it for the purpose, and which moves down between its leads as the drill sinks. The weight of the hammer replaces the tripod and weights. The whole drill, with its attached string of tools and hammer, hangs by tackle from the sheave on top of the pile driver leads, and may be hoisted or lowered at will by means of the hoisting engine. In starting a hole, the drill is hoisted up and drill steels of sufficient length to give a hole the full depth required without changing bits are inserted, joined together by double cheeks, so-called extension pieces.

When, in drilling, the feed of the drill runs out, 30 inches in this case, the drill cylinder is raised by turning the crank which moves the feed screw until it reaches the top of the shell, and then by means of the hoisting engine the whole mass is lowered down the said 30 inches and the drill started again. During drilling a stream of water plays into the bottom of the hole, as described above, causing the crushed rock to rise and flow out at top of the hole. From the platform of the pile-driver scow, down to rock surface, the drill rod passes through a tube which is 12 inches at top, is telescopic to adjust it to varying water depths, and is narrowed down to 4 inches near the rock surface. As the

bit is 3 inches in diameter, this 4-inch tube within which it works serves to guide it in starting the hole. Close to rock surface the 4-inch tube has a cross with open side branches through which the stream of water and chippings flow out. After drilling, each hole is plugged with a wooden plug, having a rope and float attached. In this way the holes are readily found again when required for charging and are kept clear of mud dropping into them. Dynamite, containing 60 per cent nitroglycerin, is being used, the charges fired in sets by electricity.

Cleaning Matadero Creek.—Acting under authority contained in indorsement from adjutant-general's office, Department of Habana, December 30, 1899, O. C. E. file No. 8913-1, a labor crew, consisting of a foreman and 12 men, was started on the work of recleaning this creek January 4, 1900. The creek was cleaned in April, 1899, but on account of its sluggish current and the filth that flows into it from the slaughterhouses and the candle factories, as well as the sewerage from adjacent houses, it had become foul again. The grass and weeds along the bank were cut, and all obstructions in the bed of the stream were removed. All refuse was disinfected with lime and carted to the garbage dump. About 209 cubic meters of material were carted away. The work was completed February 3, 1900.

Expenses incurred:

| | |
|-----------------|---------------|
| Labor | \$366. 00 |
| Materials | 127. 25 |
| | <hr/> 493. 25 |

Since the above mentioned work was done, the regular harbor-cleaning patrol crew has made weekly trips over this creek, cleaning the banks and sides of the stream, thus preventing any great accumulation of filth.

Cabana.—The work of renovation and repair of this fortress has been carried on by this department, and was practically completed and reported upon June 30, 1899. There have been from time to time slight repairs since that date, as follows: Renewing eave troughs and water pipe; laying board floor in 4 rooms for post exchange; constructing a picket fence to surround the spot where executions took place; giving the casemates and yards a thorough cleaning after the troops had moved from the fortress into camp near by.

Expenses incurred:

| | |
|-----------------|---------------|
| Labor | \$197. 00 |
| Materials | 233. 29 |
| | <hr/> 430. 29 |

Tide gauges.—Three tide gauges established by the department of sewers at Tallapiedra wharf, the Maestranza and San Rafael, respectively, were put under the control of this department in November, 1899, and with slight interruptions have been in operation since. In the early part of November the gauge at San Rafael was broken down by a storm, and it was moved to San Lazaro, where it could be established with greater security. A channel 2 feet wide and 15 feet long was cut through the solid rock to a depth of 1 foot below low water and the gauge was placed at the inner end of this channel and connected with the sea by means of a 2-inch pipe. The space between the gauge and the sea was then filled with concrete and a house built over the gauge. The tides at the Maestranza and Tallapiedra gauges are affected by the winds, which cause a temporary change in water

level, for periods of many hours at a time. These changes make of the tidal curve a sinuous curve of long undulations, showing secondary waves frequently over an hour in length, each of varying amplitude. When the wind is not in the direction affecting the water at said localities, or when there is a calm, the recording pencil will trace a smooth uniform tide curve. The curve of the San Lazaro (Gulf) gauge does not show these secondary waves. Daily inspections are made of each gauge, and the results now obtained are very satisfactory. The expenses attached to this work have been paid by the department of sewers.

TABLES DEDUCED FROM OBSERVATIONS AT SAN LAZARO GAUGE.

TIDES OF THE GULF.

| | Mean range. | Maximum range. | Minimum range. | Maximum difference in water level. | Mean sea level referred to city datum. | Mean high water referred to city datum. | Mean low water referred to city datum. | Highest high water referred to city datum. | Lowest low water referred to city datum. |
|-----------------------------|--------------|----------------|----------------|------------------------------------|----------------------------------------|-----------------------------------------|----------------------------------------|--------------------------------------------|------------------------------------------|
| 1899. | <i>Fect.</i> | <i>Fect.</i> | <i>Fect.</i> | <i>Fect.</i> | <i>Fect.</i> | <i>Fect.</i> | <i>Fect.</i> | <i>Fect.</i> | <i>Fect.</i> |
| November ¹ | 0.860 | 2.15 | 0.18 | 2.32 | +0.307 | +0.737 | -0.123 | +1.48 | -0.84 |
| December..... | .903 | 2.12 | .08 | 2.17 | -.113 | +.339 | -.565 | +1.25 | -.92 |
| 1900. | | | | | | | | | |
| January..... | .878 | 2.05 | .05 | 2.37 | -.145 | +.294 | -.584 | +1.26 | -1.11 |
| February..... | .903 | 1.76 | .05 | 2.18 | +.043 | +.496 | -.406 | +1.22 | -.96 |
| March..... | .976 | 1.91 | .05 | 2.28 | +.143 | +.631 | -.345 | +1.42 | -.86 |
| April..... | .952 | 2.13 | .06 | 2.62 | +.288 | +.764 | -.188 | +1.72 | -.90 |
| May..... | .937 | 2.22 | .12 | 2.28 | +.364 | +.832 | -.105 | +1.76 | -.92 |
| June..... | .903 | 2.20 | .14 | 2.20 | +.274 | +.726 | -.176 | +1.54 | -.66 |

¹ Observations only cover the last 13 days of the month.

Borings.—The hand-power drilling plant and crew of this department were employed from December 22, 1899, to March 30, 1900, in making borings in the harbor for the department of sewers. Thirty-five holes were drilled, varying in depth from 11 to 35 meters.

Summary of receipts and expenditures during the fiscal year 1900.

Receipts:

| | |
|-------------------------------------------------------|------------|
| Balance on hand July 1, 1899, special allotments..... | \$2,637.21 |
| Regular allotments..... | 70,646.00 |
| Regular allotments for June, to be received..... | 6,000.00 |
| Special allotments..... | 20,442.76 |
| Miscellaneous sources..... | 28,538.13 |

Total.....128,264.10

Expenditures:

| | |
|--------------------------------------------------------------------------|-------------|
| Office and superintendence..... | \$13,591.73 |
| Dredges..... | 34,943.59 |
| Tugs..... | 22,719.03 |
| Tug hire..... | 3,145.00 |
| Scows, repairs—current and extraordinary..... | 11,083.40 |
| Wharf construction..... | 14,519.18 |
| Wharves, care and repair..... | 16,449.96 |
| Cleaning harbor front and Slaughterhouse Creek..... | 3,076.50 |
| Drillers..... | 4,622.76 |
| Current repairs, pile drivers, rowboats, warehouses, and water boat..... | 1,481.52 |
| Rowboat transfer service..... | 451.51 |
| Blasting materials..... | 787.07 |

| | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Minor supplies, services, and repairs, not chargeable to special headings, such as electric light, cartage, subscription to official papers, disinfectants, diving apparatus, etc..... | 1,367.68 |
| | 128,238.94 |

Balance June 30, 1900.....25.16

Diagram showing
Monthly variations in mean sea level, Mean high water
and mean low water.

Havana, Cuba, December 1st 1899 to July 1st 1900.

San Lazaro Gange.

| References | 1899 December | 1900 January | 1900 February | 1900 March | 1900 April | 1900 May | 1900 June |
|-----------------|------------------|-----------------|------------------|---------------|---------------|-------------|--------------|
| | | | | | (+ 0.764) | (+ 0.882) | (+ 0.726) |
| | | | (+ 0.496) | (+ 0.631) | | | |
| Mean high water | (+ 0.339) | (+ 0.294) | | | (+ 0.288) | (+ 0.364) | (+ 0.274) |
| City Datum | | | (+ 0.045) | (+ 0.143) | | | |
| Mean sea level | (- 0.119) | (- 0.145) | | | (- 0.188) | (- 0.106) | (- 0.116) |
| | | | | (- 0.345) | | | |
| Mean low water | (- 0.565) | (- 0.584) | (- 0.406) | | | | |

Office of Chief Engineer,
Division of Cuba

A. H. Weber
Asst Engr

Engineer Department
Division of Cuba

To accompany annual report for fiscal
year ending June 30-1900

H. M. Black

Major Corps of Engineers U.S.A.
Chief Engineer,
Division of Cuba

GENERAL REMARKS AND RECOMMENDATIONS.

The native hard-wood piles (principally Jucaro) have, as a rule, on account of their long life, been used in all wharf and pier construction in Habana Harbor in preference to imported piles, although the latter, even when treated with creosote, are cheaper than the native piles. The cost of creosoted pine piles, delivered in Habana, is from 40 cents to 50 cents per linear foot, and the cost of Jucaro piles is 50 cents to 60 cents per foot. A comparison of the life of creosoted and native hard-wood piles has not been made, as none of the former were in use before the American occupation. The quartermaster's department used creosoted pine piles in the construction of Tricornia wharf in February, 1899, and a careful examination of these piles, after a service of 16 months, has just been made. There is a very heavy growth of "escaramujo" (barnacle formation) on each pile, extending from about high-tide line down to 5 or 6 feet below low water and even to some extent to a greater depth. This growth is from 2 to 6 inches in thickness and is composed of miscellaneous collection of sea plant and animal life from the minutest insects to shellfish of various kinds and sizes, of the mussel and crab species. It is not thought the teredo is among them. None of these animals seem to bore into the timber, but simply to cling to and become a part of it, gradually producing a surface wear, the greatest effect being at or near mean water level. As yet there are no evidences of wear on these piles.

The life of the native piles is usually reckoned at from 20 to 30 years, although some have been found to be perfectly sound after 80 years.

By means of the newly acquired steam drill for submarine work the rate of progress in drilling has been increased from about 5 feet per day, as obtained with the hand driller, to 48 feet per day, and the cost reduced from \$2.50 to \$3 per foot to \$0.25 to \$0.40 per foot.

As stated elsewhere in this report, the number of dump scows and the tug service are not equal to the capacity of the dredges, and it is earnestly recommended that the plant be increased by 2 scows and 1 tug. Years of experience have shown that there is a continuous deposit in the upper end of the bay and that it has been necessary to resort to dredging at intervals of from one to two years in order to maintain a given depth in the channel or in front of the wharves. The natural deposit from the streams and sewage and from the wash of the bank fully equals the capacity of the dredging plant and it should be operated continuously at its full capacity.

CUBAN WOODS.

There are some 300 varieties of woods in the island of Cuba, about 40 of which are well known and are in general use in Cuba, but not in the United States. They are almost all of very fine grain and take a high polish. The beauty of their color must be seen to be appreciated. To architects and interior decorators their use will afford opportunities for very fine effects. It has been a shock to the Americans to find wharves built of mahogany, acana, and other beautiful woods, and the same woods used for railway ties, floor and roof beams, etc. The cost of the woods now places them beyond the reach of the engineer, excepting for very special work. The following brief description of these has been translated from a work by Lieut. Col. Nicholas Valdes of the Spanish Army, who in turn says that he obtained

his notes from a review or memoir of the artillery corps, and adds this note:

Presumably the resistance of these woods was tested in pieces of 1 yard long by 1 inch square in section. As the pieces must have been placed horizontally, with their ends resting on supports and afterwards loaded with weights in pounds, these weights are those marked as limit ones in the description, and as the rupture could not occur without more or less flexure taking place the specimens to be tested must have been firmly fixed at the abutments for about 3 or 4 inches.

Granting this, there will result a clear span of 30 inches or 0.70 meter between supports. This information was not set forth in the table of "Memoirs" and needed in order to deduce the tensile strength of the specimens of timber.

Applying the formula of resistance to tension when the section is a square—

$$F = \frac{3 \text{ Pc.}}{2b^3}$$

the assumed values being as follows:

$$C = 30'' = 0.696 \text{ meter,}$$

$$B = 0.023 \text{ meter,}$$

we have

$$F = 45 \text{ P. per sq. inch of section, and}$$

$$F = 8.56 \text{ P. per sq. centimeter.}$$

No. 1. Aceitillo (*Ercostema caribeum*), family Rubiaceae: A tree which attains a height of 6 meters; has a hard heart; color white, slightly yellow in the part next to the heart, which is dark with black streaks; fibers straight and very elastic; very hard to work, and is employed in constructions which require great elasticity, and its principal application is in the manufacture of furniture.

| | Kilos. |
|------------------------------------------------------------------------|--------|
| Specific weight | 0.860 |
| Resistance in the direction of the fibers, per square centimeter | 500 |
| Resistance perpendicularly to the fibers, per square centimeter | 280 |
| Resistance to tension, per square centimeter | 1,600 |
| Resistance to torsion, per square centimeter | 250 |

No. 2. Acana (*Bassia albenscens*, Gris): Hard wood, compact and but slightly elastic; light violet color when recently cut, and very dark when old; breaks short, leaving large splinters, but short and thick. Trunk attains a height of 8.50 to 10 meters, and circumference of from 1.50 to 2 meters.

It is used in structures as floor and tie beams, and because it keeps well under water and under wet soils it is used to great advantage in all wharf constructions, though not as piles. It is also used in the manufacture of furniture.

| | |
|-----------------------------------------------|-----------------|
| Specific gravity | 1.23 |
| Breaking load | 538 pounds |
| Tensile strength, per square centimeter | 2,062 kilograms |

No. 3. Almendro (*Laplacea curtiana* De Rich): Trunk attains a height of 16.50 to 20 meters and from 1.50 to 2 meters circumference, wood hard, compact and elastic, color a dirty white, more or less tinted with red, and the heart and leaves brownish red. It breaks vertically in fibers long and thin. It gives shavings which are soft, long and curled. This wood is employed in constructions as crossbeams, wall plates, etc. Grows abundantly in the eastern part of the Vuelta Arriba.

| | Kilograms. |
|---------------------------------------------|------------|
| Specific gravity | 1.10 |
| Actual breaking load of test specimen | 477 |
| Tensile strength | 1,828 |

NOTE.—There is a variety with almost identically the same properties called "Almendrillo" (*Rhamnidium revolutum*).

No. 4. Arabo. (*Erythryllum obovatum* De Macf): The trunk of this tree reaches a height of 7 meters and a diameter of 0.30 meters. The wood is almost all heart and of a reddish yellow, and outer wood clean, but as hard as the center; fibers straight and very compact. This wood is used to great advantage in telegraph poles, because of its capacity to resist moisture under exposure to the outer air, which property it possesses to a greater degree than other woods; also in beams it can be used in pieces subject to torsional strains, because its coefficient of rupture under such strains is 298 kilograms. Its density green is 1.010, and dry, 0.970; its resistance to pressure in the direction of the fibers is 654 kilograms per square centimeter, and across the fibers 290 kilograms.

| | Kilograms. |
|-----------------------------------------------|------------|
| Tensile strength, per square centimeter | 1,500 |

No. 5. Caoba mahogany (*Savietenia mahogan* De Linneo) family Terebinteaceas: Tree with a very large trunk, up to a diameter of 6 to 7 feet, of very slow growth, reaches a great height, and the trunk straight for 12 meters, color of wood reddish, more or less light and handsomely streaked. There grows in Cuba the variety called "Caracolillo," which for furniture is unequalled. The abundance in which it grows makes this wood cheap, and the ease with which it can be worked, together with its strength, makes it applicable not only for furniture, but for doors, floors, stairways, etc., as also in naval construction, wharves, etc. There has been found on Atocha Shoal, in the bay of Habana, a piece of this wood immersed eighty-three years under water without any alteration whatever.

| | Kilograms. |
|-----------------------------------------------------------------------------------|------------|
| Specific weight is..... | 0.85 |
| Resistance to pressure in the direction of the fibers, per square centimeter..... | 442 |
| Across the fibers, per square centimeter..... | 304 |
| Breaking point, by twisting..... | 180 |
| Breaking point, under tension, per square centimeter..... | 850 |

No. 6. Carne De Doncella (*Byrsomina lucida* De Kunth), family Malpighiaceas: Tree which reaches a height of 7 to 8 meters and the trunk of same has a height of 4 to 5 meters, diameter of 0.30 to 0.50 meters. The wood is compact, elastic, and resistant, of a beautiful bright rose color. heart and outside wood of equal strength, crossed fibers, cracks slightly when exposed to the air. It is used in carpenter and furniture work; makes good floor and tie beams, etc., which are lasting when not in proximity to water. It is used to advantage as caps and floor beams in wharves, in which same have been known to keep for from eighteen to twenty years.

| | Kilograms. |
|------------------------------------------------------------|------------|
| Specific weight..... | 1.00 |
| Resistance to pressure in the direction of the fibers..... | 912 |
| Resistance to pressure across fibers..... | 370 |
| Breaking point, per square centimeter..... | 250 |
| Resistance to tension, per square centimeter..... | 1,408 |

There is a species which has equal applications and the only difference is that the color is much lighter, and is called "Carne doncella clara" and is employed in furniture.

No. 7. Cedro (*Cedrela odorata* Linneo), family Miliaceas: Tree is very well known because of its wide distribution. Of very rapid growth and attains a height of as much as 30 meters, and the trunk a diameter of up to 3 meters. Has a good deal of sap wood, but the heart is very wide, and from it boards up to 2.50 meters width can be sawn. Its color is red, variegated streaks, free of knots, and porous, weak in texture, and with a strong odor of juniper.

There is no substitute for it in Cuba for the manufacture of cigar boxes, which is its principal application. It is also employed in furniture manufacture and is used to imitate mahogany, also for constructions in dry places, and also for making doors, blinds, etc., replacing pine to advantage.

On the Atocha Shoal there have been found pieces of this wood immersed in water eighty-three years in a perfect state of preservation.

| | Kilograms. |
|---------------------------------------------------------------------|------------|
| Specific weight..... | 0.0450 |
| Resistance per cubic centimeter in the direction of the fibers..... | 470 |
| Resistance per cubic centimeter across the fibers..... | 60 |
| Resistance to tension per square centimeter..... | 690 |
| Resistance to breaking, by torsion..... | 194 |

No. 8. Cuajani (*Cerasus occidentalis* Linneo, *Prunus Cerasus occidentalis* Swartz), family rosaceas: Tree which reaches a height of 15 meters and its trunk a diameter of 0.30 or 0.40 meters. The wood is almost all heart, strong, compact, of a yellowish pink color, straight meshy fiber. It is employed in construction under cover not exposed to the weather and in carriage manufacture.

| | Kilograms. |
|-----------------------------------------------------|------------|
| Specific weight..... | 0.80 |
| Resistance to pressure lengthwise of the fiber..... | 5.50 |
| Resistance to pressure across the fibers..... | 2.20 |
| Breaking point torsion..... | 2.54 |
| Resistance to tension..... | 8.00 |

No. 9. Chicharron prieto (*Chuncoa obovata* Poir): Hard wood and but slightly elastic, breaks obliquely in large twisted fibers. The shavings of this wood are long, smooth and curled, color ashy, the trunk reaches a height of 8.50 to 10 meters and 1.25 meters circumference. Its wood is used in naval construction for the knees of vessels.

| | Kilograms. |
|----------------------------------------------------|------------|
| Specific weight..... | 0.85 |
| Actual breaking load of specimen..... | 406 |
| Coefficient of tension, per square centimeter..... | 1,356 |

No. 10. Carey de costa (*Milleria* or *Tetracera*) not classified: A tree of small dimensions, heart wood dark with streaks running parallel to the fibers; exterior pink yellow and as hard as the heart, has considerable elasticity and keeps well under water and in humid places. On account of its small size it is used only in cabinetwork, especially for canes, on account of its beautiful streaks.

| | Kilograms. |
|------------------------------------------------------|------------|
| Specific weight..... | 0.95 |
| Resistance to pressure lengthwise of the fibers..... | 590 |
| Resistance across the fibers..... | 350 |
| Resistance to twisting..... | 300 |
| Resistance to tension..... | 1,100 |

No. 11. Dagame (*Calycophyllum candidissimum*), family Rubiaceae: Tree whose trunk reaches a height of 8 to 10 meters, branchless up to the apex. All heartwood clean and of equal resistance in all parts, of a yellow color, compact and straight fiber. Breaks vertically in long and thin fibers. The texture of this wood is rough to the touch, shavings long and much curled. This wood is used in all classes of construction, especially for tie and floor beams in vessels and houses. It is used also in constructing machines, carriages, etc.

| | Kilograms. |
|-------------------------------------------------------------------------|------------|
| Density..... | 0.85 |
| Resistance to pressure lengthwise to fibers, per square centimeter..... | 700 |
| Resistance to pressure across fibers, per square centimeter..... | 350 |
| Coefficient of torsion, per square centimeter..... | 190 |
| Coefficient of tension, per square centimeter..... | 1,400 |

No. 12. Encina de Cuba (*Quercus virens* D. C.): Tree which propagates by seed in rich lands, but does not reach the height of the same tree in Spain; grows to a height of only from 15 to 17 yards and greatly spreads its branches.

The wood is of a dirty white color, slightly yellow, streaky, hard, and resembling European oak. The bark contains a great deal of tannin, which is used by tanners for curing skins. The wood is very strong and is used by rural carpenters. It is found in Pinar del Rio, Banos, Guane, Macurijes, etc.

| | Kilograms. |
|---------------------------------|------------|
| Specific weight..... | 0.84 |
| (Resistant powers not studied.) | |

No. 13. Ebano Real (*Ebenus creta* Linneo), family Leguminosae: Tree which attains a small height, 5 to 6 meters, and a circumference of 0.80 to 1 meter, on account of which and also the scarcity of same is not used in construction. Wood is hard, compact, and brittle, and breaks obliquely in splinters and short fibers. Color pure black, and lustrous after being worked up. Valued highly in furniture and cabinetworks.

| | |
|----------------------------------------------------|------------------|
| Actual breaking load of specimen..... | pounds.. 305 |
| Density..... | kilograms.. 1.19 |
| Coefficient of tension, per square centimeter..... | do.... 1,169 |

No. 14. Fustete, Fustic (*Machara tinctoria*, Kunth): Wood not very hard and somewhat elastic, breaks short and leaves large fibers in the interior part. Color yellow, which darkens with time. Trunk reaches a height of 10 to 12 meters by 2 to 3 in circumference. Shavings are short, rough, and but slightly curled. It is used in carriage and furniture manufacture and also for piles, posts, and for making stairs.

| | |
|----------------------------------------------------|-------------------|
| Specific weight..... | kilograms.. 0.95 |
| Breaking load of specimen..... | pounds.. 305 |
| Coefficient of tension, per square centimeter..... | kilograms.. 1,169 |

No. 15. Frijolillo (*Lonchocarpus talifolio* Kunth): Tree which reaches a height of 18 to 20 yards, very common, color pale yellow, heart slightly darker, is very solid, compact and resistant, employed for pillars both in and out of water, piles, framing, and in all kinds of structures. Specific weight, 1.06 kilograms.

There is another species, "Frijolillo prieto" (*Lonchocarpus sericos*), having the same properties and uses, only it is heavier and more resistant.

| | Kilograms. |
|----------------------------------------|------------|
| Specific weight..... | 1.06 |
| The resistances have not been studied. | |

No. 16. Guasima (*Guazuma ulmifolia*), family Burseraceae: Beautiful tree whose height reaches 15 meters and the trunk of which is from 6 to 8 meters high by 1 to 2 meters in diameter; wood without sapwood, all of same resistance, other yellow color, meshy fiber, sound, does not crack. It is used principally in cross-ties for railroads.

| | Kilograms. |
|----------------------------------------------------------------------------|------------|
| Specific weight..... | 0.52 |
| Resistance to pressure lengthwise of the fibers per square centimeter..... | 280 |
| Resistance across the fiber per square centimeter..... | 100 |
| Resistance to twisting per square centimeter..... | 220 |
| Coefficient of tension per square centimeter..... | 660 |

No. 17. Guayacan negro (*Lignum vitæ*), family Rutaceas Linneo (*Guajacum officinale*): A hard and brittle wood, breaks short, color dark gray, clear streaks. Trunk reaches a height of 16 to 20 meters and up to 1 meter in diameter. It is so very hard that on planing same it gives no shavings, only sawdust, and because of this it is difficult to work.

On account of its hardness it is employed for pulleys of blocks for ships in naval construction and in pieces which are subjected to great friction, such as teeth for wheels, axles, and all classes of constructions which require extraordinary solidity. Remains intact indefinitely below water, proved by pieces taken from the water after an immersion of eighty-four years. The sap is medicinal.

| | |
|--------------------------------------|------------|
| | Kilograms. |
| Specific weight | 1.29 |
| Breaking load of test specimen | 2.13 |
| Coefficient of tension | 816 |

There is another variety, known by the name of white guayacan, whose color is yellow and whose properties are the same as the other, only the trunk reaches a height of 10 to 11 meters. Its uses are the same as the first named, especially where resistance to great pressure is required.

| | |
|------------------------------------------------------------------------------|------------|
| | Kilograms. |
| Specific weight | 1.17 |
| Resistance to pressure lengthwise of the fibers, per square centimeter | 900 |
| Resistance across the fiber per square inch | 361 |
| Coefficient of torsion | 380 |
| Coefficient of tension | 720 |

No. 18. Jaimiqui (*Byrsonimia linda* Kunth): Tree which grows to a height of 12 meters and has a trunk of 0.80 meter diameter, wood fine in texture, yellowish red, somewhat like the wood called "Carne Doncella" (Maiden flesh), of a compact and even fiber. It is employed in all kinds of construction and in carpenter work.

| | |
|-----------------------------------------------------------------|------------|
| | Kilograms. |
| Specific weight | 9.95 |
| Resistance lengthwise of the fibers per square centimeter | 540 |
| Resistance across the fibers | 300 |
| Resistance to twisting | 312 |
| Resistance to tension | 1,330 |

No. 19. Jamaguey or Yamaguey (*Beraira mucronata* Rich, *Cuarea trichilioide* Linneo), family Malceas: Tree of 10 to 12 meters height, trunk has a diameter of 0.40 to 0.50 meter. Its wood is of equal texture, straight fiber somewhat meshed, color of wood yellowish red, and a section running with the fibers presents dark stains. It is employed in railroad ties on account of the superior way it resists exposure. Can be used in all classes of construction, as well as in carpenter work.

| | |
|---------------------------------------------------------------|------------|
| | Kilograms. |
| Specific weight | 0.700 |
| Resistance to pressure with fiber per square centimeter | 460 |
| Resistance across the fiber per square centimeter | 180 |
| Resistance to twisting | 190 |
| Resistance to torsion per square centimeter | 1,300 |

No. 20. Jagua (*Genipa americana*), family Rubiaceas: Tree whose straight trunk reaches a height of 8 to 10 meters and 0.30 or 0.40 meter diameter. Its wood has a yellow center and streaked with black at the extremes, fiber undulating, easy to work. It is employed in posts, gunstocks, transoms, plow handles, and for tool handles; is employed in construction, and principally as braces or tie timbers.

| | |
|---------------------------------------------------------------|------------|
| | Kilograms. |
| Specific weight | 0.970 |
| Resistance to pressure with fiber per square centimeter | 630 |
| Resistance across the fiber | 350 |
| Twisting resistance per square centimeter | 179 |
| Resistance to tension per square centimeter | 720 |

No. 21. Jiqui de costa (*Malpighis obovata* Kunth): Tree whose trunk reaches a height of 12 meters. Wood very hard, strong, and heavy, with a very small dark-red heart; color of wood whitish yellow and elastic; very hard to work and very resistant; it remains in good condition for an indefinite time under water and in humid places, for which reason this wood can not be excelled for piles and all construction in damp places; it is free from attacks of all insects.

| | |
|---------------------------------------------------------------|------------|
| | Kilograms. |
| Specific weight per square centimeter | 1.20 |
| Resistance to pressure with fiber per square centimeter | 873 |
| Resistance across the fibers per square centimeter | 450 |
| Resistance to twisting per square centimeter | 305 |
| Resistance to tension per square centimeter | 1,023 |

There is a variety known by the name of Jiqui de Ley (*Bumelia nigra*), dark-violet color streaked with black, of same properties as above.

No. 22. Jique moruro (*Acacia littoralis* Kunth): Strong, wood compact, which breaks short and in small splinters, shavings short, rough, and curled, color light gray when new and dark gray when older. Trunk reaches a height of from 8 to 10 meters by 6 or more in circumference.

It is used as cane rollers on plantation, for wheel hubs and heavy work.

| | | |
|---------------------------------------------------|-------------|-------|
| Specific weight..... | kilogram.. | 0.87 |
| Breaking load of test specimen..... | pounds.. | 380 |
| Coefficient of tension per square centimeter..... | kilograms.. | 1,457 |

There exists a variety called *Jique hediondo*, of a disagreeable odor, which only reaches a height of 5 or 6 meters; wood red color, and is used as sills, cross-ties, pillars, etc.

| | | |
|---------------------------------------------------|-------------|-------|
| Specific weight..... | kilogram.. | 0.77 |
| Breaking load of specimen..... | pounds.. | 450 |
| Coefficient of tension per square centimeter..... | kilograms.. | 1,649 |

No. 23. Jocuma (*Syderoxylon mastichodron* De Jacq., *Syderoxylon pallidum*), family Sapotaceas: This tree reaches a height of 15 meters. Its wood is hard and strong, heart yellow color; more or less dark, according to the age of the tree. It is employed in cabinetwork and construction; in wharf construction it can be used as piles, which resist the action of water as well as Jucaro, and in flooring gives excellent results when the heart is used.

| | | |
|---------------------------------------------------------------|------------|------|
| | Kilograms. | |
| Density..... | | 1.02 |
| Resistance to pressure with fibers per square centimeter..... | | 600 |
| Resistance across the fiber per square centimeter..... | | 234 |
| Resistance to twisting per square centimeter..... | | 312 |
| Coefficient of tension per square centimeter..... | | 783 |

No. 24. Jucaro prieto (*Bucida capitata* Wahl), family Combretaceas: This tree grows to a height of 20 to 22 meters and the trunk has a diameter of 1 meter. Its wood is strong, hard, and compact, color a yellowish dark green, and the heart is darker, with longitudinal interrupted streaks dark and clear; it is very strong in every sense, very elastic, and will not decay below water; it is employed in all classes of construction; its principal application is for wharf piles, for which it has no substitute; it is also employed with excellent results in every part of wharf construction.

| | | |
|---------------------------------------------------------------------------|------------|-------|
| | Kilograms. | |
| Specific weight..... | | 1.14 |
| Resistance to pressure lengthwise of the fiber per square centimeter..... | | 810 |
| Resistance across the fiber..... | | 360 |
| Resistance to torsion..... | | 315 |
| Coefficient of tension..... | | 2,180 |

This wood is very abundant and is found in all provinces of the island.

There is a variety known as yellow Jucaro, which can not be used as piles, as the water attacks it. It is distinguished by its color after planing, which is much lighter than that of Jucaro prieto.

| | | |
|----------------------------------------------|------------|------|
| | Kilograms. | |
| Specific weight..... | | 1.13 |
| Resistance across the fiber..... | | 2.00 |
| Resistance to pressure with fiber..... | | 6.54 |
| Resistance twisting..... | | 3.86 |
| Coefficient of tension per square meter..... | | 890 |

No. 25. Majagua azul (*Paritum elatum* Richard, *Hybiscus elatus* Swartz), family Malvaceas (sometimes confounded with *Hybiscus Tiliaceus* of Linneo, which is smaller in all its parts): This tree reaches a height of 15 to 18 meters, and the trunk 1 meter in diameter; wood whitish yellow and the center of the heart ashy blue; is hard, very elastic and resistant, straight fiber and easy to work, all of which properties make this wood much valued for carriage construction and in general all construction which must resist great flexure. Resists well the action of water and in humid ground and in hydraulic appliances. There is a variety called Majagua Blanca, the wood of which is a light yellow and can be put to some of the uses of the former.

| | | |
|--------------------------------------------------------------|------------|-------|
| | Kilograms. | |
| Specific weight..... | | 0.740 |
| Resistance to pressure with fiber per square centimeter..... | | 605 |
| Resistance across the fiber..... | | 274 |
| Coefficient of torsion..... | | 214 |
| Coefficient of tension per square centimeter..... | | 2,151 |

No. 26. Naranjo (*Citron vulgaria*), family Aurantiaceas: Tree of some size, which reaches a height of 7 meters and 0.50 meter in diameter. Its wood is yellowish

white, straight, close fiber, very elastic and resistant, easy to work; is employed in construction, tool handles, carpenter and furniture work.

| | | |
|--------------------------------------------------------------|------------|-------|
| Density..... | Kilograms. | 0.90 |
| Resistance to pressure with fiber per square centimeter..... | | 500 |
| Resistance across the fiber..... | | 230 |
| Coefficient of torsion..... | | 320 |
| Coefficient of tension per square centimeter..... | | 1,740 |

No. 27. *Olive*: Must not be confounded with the Oleo Europea Linneo, European olive tree. On account of its color it may be easily confounded with the true olive. (Has not been classified nor studied as to its resistance). It is used to considerable extent in furniture.

No. 28. *Ocuje macho* (*Calaphyllum calaba* Jacq.): Wood very pliable and which breaks obliquely, giving large, smooth, and curly shavings, color ocher with some gray streaks. Trunk attains a height of 28 meters by 3.50 in circumference, much used in marine construction for planking and masts, derrick legs, and crank arms.

| | | |
|--------------------------------|-------------|-------|
| Specific weight..... | kilogram.. | 0.99 |
| Breaking load of specimen..... | pounds.. | 276 |
| Coefficient of tension..... | kilograms.. | 1,058 |

No. 29. *Roble blanco* (*Bigononia pentaphylla* Griss), *Roble real* (*Tocoma longiflora* Griss): There exist various classes of roble (oak) whose properties are alike, differing only in the color, from which they take their name, such as black roble, bombo, yellow, and simply roble.

Grows to a height of 11 meters. Its wood is of a uniform texture, very elastic and resistant, straight fiber, very easy to work; is employed in naval construction not directly exposed to the water. It is also employed in all classes of construction and in carpenter work in general. As this tree is attacked by an insect, it is difficult to preserve same unless worked immediately after cutting down.

| | | |
|-----------------------------------------|-------------------------|-------|
| Specific weight..... | Kilograms. | 0.79 |
| Resistance to pressure with fibers..... | per square centimeter.. | 510 |
| Resistance across the fibers..... | do..... | 300 |
| Coefficient of rupture..... | do..... | 300 |
| Coefficient of tension..... | do..... | 1,160 |

No. 30. *Roble guayo* (*Buoneria juculenta*), family Cordiaceas: Tree of about 11 meters in height by 1 meter diameter. Its wood is of a dark color and of uniform texture, very elastic and easy to work, resistant, fiber straight. It is employed in construction and furniture.

| | | |
|-----------------------------------------|-------------------------|-------|
| Specific weight..... | Kilograms. | 1.68 |
| Resistance to pressure with fibers..... | per square centimeter.. | 530 |
| Coefficient of torsion..... | do..... | 300 |
| Coefficient of tension..... | do..... | 1,200 |

No. 31. *Sabicu* (*Acacia formosa*, *Lysiloma sabicu* Benth), family Manosas: Tree which reaches large dimensions, from which are obtained boards and planks of 1 meter in width. Wood is all heart, color dark purple (violet), strong and compact, very elastic and resistant, very easy to work. It is employed in naval construction, also for making carts, in carpentry, and work of all kinds. Resists well exposure to the weather but not immersion in water, very abundant in all parts of the island.

| | | |
|-----------------------------------------|-------------------------|-------|
| Specific weight..... | Kilograms. | 0.90 |
| Resistance to pressure with fibers..... | per square centimeter.. | 712 |
| Resistance across fibers..... | do..... | 402 |
| Resistance to twisting..... | do..... | 312 |
| Coefficient of tension..... | do..... | 1,353 |

No. 32. *Yaba* (*Andria inermis* Kunth), family Leguminosas: This tree sometimes attains a height of 15 meters and a diameter of 1 meter. Its wood is not elastic, is brittle and compact; color is like yellow pine, and it would be taken for yellow pine were it not that its density is much greater. Its shavings are long and rough, but this wood when old gives no shavings. Its fiber is straight lengthwise, and undulating crosswise; contains a resin which on burning gives a smoke hurtful to the eyes.

| | | |
|--------------------------------------|-------------------------|------|
| Specific weight..... | Kilograms. | 0.82 |
| Pressure resistance with fibers..... | per square centimeter.. | 610 |
| Resistance across fibers..... | do..... | 250 |
| Resistance to twisting..... | do..... | 165 |
| Coefficient of tension..... | do..... | 423 |

No. 33. *Yaity* (*Excavaria lucida* Hoarts): A beautiful wood of a very dark color with bright streaks. The handsome streaked appearance makes it highly valued in

cabinetwork. Hard, elastic, compact, and of straight fiber. Its resistance has not been studied. Specific weight, 1.30 kilograms.

No. 34. Yaya (*Guatteria virgata* Dun): Hard wood, compact, and but slightly elastic. It breaks obliquely. Its shavings are long, rough, and curly. Color whitish. It warps very much, and on this account has very little application except for light beams. Its trunk grows 7 meters high by 0.30 meter circumference.

| | |
|---------------------------------|------------|
| | Kilograms. |
| Specific weight | 1.02 |
| Breaking load of specimen | 280 |
| Coefficient of tension | 1,164 |

No. 35. Llana (*Conocarpus erecta*), family Combretaceas: Tree of small height, dark wood, black heart, like ebony, for which it may be mistaken. Fiber straight, elastic, and very resistant to tension and pressure. It is employed in shipbuilding for knees, and may be adapted to all classes of construction, but can only be used in small pieces, as the tree is very short. Keeps well below water.

| | |
|-----------------------------------------|-----------------------------|
| | Kilograms. |
| Specific weight | 1.01 |
| Resistance to pressure with fiber | per square centimeter.. 810 |
| Resistance across the fibers | do.. 810 |
| Resistance to twisting | do.. 206 |
| Coefficient of tension | do.. 206 |

No. 36. Hicaquillo (*Licania incania*): Tree reaches a height of 10 to 12 meters, wood hard and heavy, texture fibrous, fine grain, flesh color, not very intense, with streaks not very much pronounced, which gives it an appearance of jasper. Resistances not ascertained. Specific weight, 0.79 kilogram.

No. 37. Cerillo *Exostema canbeaum* Don): Tree which reaches a height of 10 to 12 yards, abundant in the south part of the island and in Pinar del Rio. Excellent wood for cabinetwork, of good weight, hard, texture fibrous and compact, yellow color, streak undulating, of more or less brilliancy, which gives the wood a beautiful aspect. Specific weight, 1.15 kilograms. Resistance not ascertained.

No. 38. Ramon de costa (*Celtis trinervia*): Wild tree which grows to a height of 13 to 14 yards. Good wood for furniture and for country buildings, shelving, pillars, and posts. Resistance not ascertained. Specific weight, 1.06 kilograms.

No. 39. Coronel: Not studied; appears to be applicable only to cabinetwork; this on account of the beauty of the wood.

No. 40. Pardillo: Strictly speaking, a shrub rather than a tree, whose wood is used in cabinetwork and for canes. Resistances not known. Heart and sap take high polish; color of heart yellow, streaked with brown; sap grayish brown.

No. 41. Incienso: Wood hard, rough, compact, but slightly elastic and resinous; breaks obliquely in fibers long and thick. The shavings are large, curly, and smooth. Color yellow white; trunk from 8 to 10 meters high. It is used for posts or pillars. Cut at the foot of the trunk it exudes a gum which is used as incense.

| | |
|----------------------------------------------------|-------------------|
| Specific weight | kilograms.. 0.93 |
| Breaking weight of specimens | pounds.. 495 |
| Coefficient of tension per square centimeter | kilograms.. 1,894 |

No. 42. Yuraguano or Miraguano (*Thrinax radiata*): Palm tree which reaches a height of 10 meters, and whose only application is for poles used as sheet piling for bulkhead walls, the tops being confined between waling pieces of hard wood. It lasts indefinitely below water. Its fiber is straight, and when cut across gives a rose-colored section full of points, which are the extremes of the fibers, the fiber being extremely hard, and the part which is a rose color very soft.

No. 43. Guarano: White wood, slightly rose color, which gets darker approaching the heart, which is a brownish color; fiber straight and in parts undulating; used for poles, piles, etc.

No. 44. Gracejo: Tree which when 15 to 17 years old has a height of 17 to 22 yards. The wood is quite hard and of reddish color; is used in buildings and is highly esteemed. Resistances not studied. There are the species "Agracejo de monte" (*Casearia criophora*), "Agracejo carbonero" (*Exostoma nerusifolia*), which are not commonly used.

No. 45. Jatia: Tree of 10 to 15 meters high, trunk 7 to 9 meters by 0.4 meter diameter; shavings whitish entire; strong and sufficiently thick; wood is of equal color; this is white yellow, and with varnishing is yellow like gold. Of erect fiber, all heart; the outside, which constitutes the wood, has the limit of hardness, breaks diagonally to flexion and tension and lengthwise to torsion. It is slightly, if at all, elastic; hardly ever used and very scarce; it is used only as posts in constructions

and is very good for furniture. It abounds in Vuelta Arriba. Is found also in Santiago province, where it is used for piles.

| | Kilograms. |
|-------------------------------------------------------|------------|
| Specific weight..... | 0.88 |
| Resistance to crushing in direction of the fiber..... | 873 |
| Resistance to crushing across the fiber..... | 450 |
| Resistance to complete crushing..... | 1,023 |
| Coefficient of torsion..... | 8,620 |
| Coefficient of breaking..... | 305 |

No. 46. Birigi (*Eugenia buxifolia*), family Myrtaceas: Tree of a good growth; shavings very thin; epidermis white, and otherwise dark; heart wood and exterior equally hard; yellowish red fiber, somewhat undulating. Is abundant in the center of the island and Vuelta Abajo; is very good for construction, although somewhat knotty. The fruit is eaten by pigs and various birds. Breaks short crosswise.

| | Kilograms. |
|-------------------------------------------------------|------------|
| Specific weight..... | 0.95 |
| Resistance to crushing in direction of the fiber..... | 650 |
| Resistance to crushing across the fiber..... | 260 |
| Resistance to complete crushing..... | 1,400 |
| Coefficient of torsion..... | 9,100 |
| Coefficient of breaking..... | 250 |

No. 47. Llamaguei: No description found. Sample shows beautiful dark yellow heart and light yellow sap wood. Close grain, density medium.

No. 48. Yaycuaje (*Hypelate panniculate* Camb.), family Sapindaceas: A common tree everywhere; has a height of 10 meters by 5 meters diameter of trunk. Wood is of equal texture, slightly yellow, fiber erect, slightly elastic and resistant, notwithstanding it is used in upright posts, crossbeams, etc. Its use is not recommended if others better can be found. Breaks lengthwise with long splinters, crosswise short, in torsion diagonally.

| | ilograms. |
|-----------------------------------------------------------|-----------|
| Specific weight..... | 0.83 |
| Resistance to crushing in the direction of the fiber..... | 300 |
| Resistance to crushing across the fiber..... | 100 |
| Resistance to complete crushing..... | 729 |
| Coefficient of torsion..... | 8,080 |
| Coefficient of breaking..... | 330 |

No. 49. Guasimilla: No description found. Sample obtained very heavy, close grain. Dark brown color, uniform throughout sample.

No. 50. Sapote negro (*Diospyros laurifolia* Rich.), family Ebenaceas: Tree whose height is from 8 to 10 meters, the wood fibrous and slightly undulating; color dark red; compact, heavy, elastic, and very resistant, particularly to pressure. Breaks off short crosswise, can be used as posts, car axles, braces, bridges, etc. Abounds in the forests on the larger part of the island. Sapote ordinary, sapote anchras (family Sapotaceas), is another tree of the same class, only does not attain more than a medium height, wood of which is white and less resistant than the sapote negro.

| | Kilograms. |
|--------------------------------------------------------|------------|
| Specific weight, sapote negro..... | 1.13 |
| Resistance to crushing in direction of the fibers..... | 672 |
| Resistance to crushing across the fiber..... | 256 |
| Resistance to complete crushing..... | 1,454 |
| Coefficient of torsion..... | 9,380 |
| Coefficient of breaking..... | 254 |

No. 51. Angelino. No description found. Sample obtained quite light, somewhat resembles cedar, but is slightly heavier and the color is prettily variegated.

No. 52. Sabina (*Juniperus sabina* Linneo), family Coniferas. Tree resembling the cypress, called by some people of the interior "enebro criollo," 12 to 15 meters high; the trunk is 0.6 meters thick, employed generally for posts and large boards; shavings somewhat dark, thin, filamentous, and slightly adherent. The wood is rose color, fine, easy to work, and of erect fiber. The tree contains acid and on this account it is employed to good advantage (as in Europe) in work below water. It may be employed very well in constructions, particularly those which require elasticity and exposure to the open air or below water or in humid lands; consequently it is very good for railroad ties; breaks in the middle of bending and crosswise to torsion or tension.

| | Kilograms. |
|-----------------------------------------------------------|------------|
| Specific weight..... | 0.55 |
| Resistance to crushing in the direction of the fiber..... | 410 |
| Resistance to crushing across the fiber..... | 130 |
| Resistance to complete crushing..... | 840 |
| Coefficient of torsion..... | 7,400 |
| Coefficient of breaking..... | 317 |

No. 53. Granadillo. No description. Very heavy, and close fiber. Heart almost black and sap light gray.

| | Kilograms. |
|-------------------------------------------------------|------------|
| Specific weight..... | 1.32 |
| Resistance to crushing in direction of the fiber..... | 1,010 |
| Resistance to crushing across the fiber..... | 680 |
| Resistance to complete crushing..... | 320 |
| Coefficient of torsion..... | 6,200 |
| Coefficient of breaking..... | 546 |

Weights of seasoned Cuban hard woods in pounds per 1,000 feet B. M. (5.2 kilograms per cubic meter.)

[Furnished by United Railway Company of Habana.]

| | | | |
|----------------------|-------|-----------------------|-------|
| Acana | 6,656 | Jaquay | 6,396 |
| Aguacatillo..... | 5,928 | Jaimiqui | 4,940 |
| Arriero | 4,784 | Jiqui de ley | 6,240 |
| Ayua | 3,744 | Jucaro negro | 5,928 |
| Azulejo | 4,784 | Liviza | 5,200 |
| Baria blanca | 4,056 | Lino | 4,160 |
| Baria prieta | 3,016 | Liru | 4,472 |
| Berryi | 5,090 | Maboa | 4,524 |
| Caimitillo | 3,692 | Macurije | 4,420 |
| Caoba | 4,420 | Majagua | 3,848 |
| Caparoto | 4,160 | Majagua blanca | 3,068 |
| Carbonero | 4,264 | Mamey | 6,188 |
| Cedro (hembra) | 1,976 | Mangle | 5,980 |
| Cedro (macho) | 2,340 | Naranjo (agrio) | 4,680 |
| Cerillo | 4,888 | Pino blanco | 2,496 |
| Cuayam | 4,160 | Pino tea | 3,848 |
| Cuero duro | 5,302 | Quebrachacha | 6,614 |
| Chicharron | 4,940 | Roble | 4,680 |
| Dagame | 4,680 | Sabicu | 4,680 |
| Ebano real | 6,136 | Sabina | 2,860 |
| Granadillo | 6,864 | Tamarindo | 4,836 |
| Guama | 5,928 | Talti | 6,448 |
| Guayacan | 5,304 | Zapote | 5,876 |
| Guarije | 5,304 | | |

SANITATION AND RENOVATION OF PUBLIC BUILDINGS AND FORTIFICATIONS.

This work was under the charge of Capt. T. L. Huston until he was transferred to the office of the chief engineer, Division of Cuba, on January 15, 1900, when he was succeeded by Mr. George W. Armitage, who was transferred from the municipal architect's department.

The personnel of the assistants consisted of J. L. Young, chief clerk; Charles Scheidemantel, stenographer; E. Z. Crucet, interpreter and clerk; M. M. Latta, F. W. Piel, C. C. Converse, Alex. Rogers, general foremen; Hubert Hines, plumbing foreman; H. G. Moore, foreman of painting; C. W. Newlin, foreman of carpenters; W. O. Ayer, assistant engineer; E. W. Shea, mechanical engineer; R. E. Moore, J. A. Vautier, Enrique Campi, draftsmen; and Henry Vinton, master of transportation.

A typical Habana building has thick walls of very porous limestone, heavily plastered, and carried from foundation to 3 feet above the roof, forming a parapet. The ground floor is of tile laid in lime mortar upon a compact bed of sand or coco, the fine refuse from the quarries. The tile roof is generally flat and constructed similar to floor of upper story. Beams of beautiful native hard wood, with their beauty covered by painting, support the tile floor, filling, and the underlaying of thick tile, which confines the filling and forms the ceiling. Windows are large in each dimensions and are inclosed by iron grating, swinging slat blinds and swinging solid blinds with one panel of glass, protected by a swinging panel. The ceilings are generally very high, 18 feet being about the standard. A colonnade generally extends along the front of the building, the columns supporting the front wall of the

upper stories, when the building is more than one story in height. The sidewalk, extending between the columns and first story wall of the building under the portico is thus protected from the sun and rain, and it is often possible to walk a considerable distance without being exposed to the weather. The buildings are constructed on classical lines, Greek and Roman styles prevailing. The type of building is admirably adapted to the climate.

A general description of the condition in which one public building was found before renovation will apply to all of them with equal force. They were filthy beyond description and generally in bad repair. No attempt had been made at sanitation. The sewers were of porous masonry, of open joints, rectangular in section, of slight fall, and sometimes clogged completely with fecal matter. The water-closets (where there were any) were of antiquated type, and installed in an unsanitary manner. In some buildings, sewers discharged into cesspools, out of which many loads of night soil were removed. The water supply was invariably inadequate, and wasted by design and leakage. The roofs were leaky and required a great deal of repairing. In charitable institutions, ventilation was frequently insufficient, and into some rooms light scarcely ever penetrated.

At the commencement of the renovation of a building disinfection was begun and was continued during the operation. Lime was used freely on all freshly excavated material and electrozone was sprayed with force pumps over every square inch of accessible area; bichloride of mercury was used when the building had an unusually bad reputation. Walls and ceilings were thoroughly brushed, washed, and scraped; floors were scrubbed, walls calcimined, and woodwork, doors, and windows were repaired and painted. A great deal of plastering was found loose and was replaced after thoroughly scraping the walls. Vitrified pipe sewers of proper dimensions were built from street sewers to wall of building; within buildings cast-iron soil pipe was used. Sewers were laid carefully and to a grade calculated to produce a velocity of 3 feet per second. Clean outs and fresh air inlets were inserted in sewers at proper points. An adequate supply of water was obtained by making suitable taps into street mains and providing for thorough circulation. At the beginning of the year 1899, when the sanitation of buildings was first commenced, there was practically no material in the market of Habana adapted to a sanitary system of plumbing or sewers, and it was doubtless true that there was not a civilian plumber in the city who could have passed the examination required to practice in a city of the United States. The problem was to get the best results possible with the material at hand, consequently, in a few of the first buildings renovated the work might not be, strictly speaking, up to standard. All work performed since the time when proper men and material could be obtained from the United States has been done according to the best United States practice, and of a class to correspond to the use to which the building was to be put; for instance, in the Ayuntamiento, part of the governor general's palace, the plumbing was on a par with that found in the best office buildings in the United States; that in the old post-office is suitable for a less pretentious office building, while that in the Compostela street orphan asylum is still another class. Plumbing is properly trapped, vented, and back aired; closets are generally porcelain bowl washouts with hard-wood seat and hard-wood cistern with copper lining, nickel-plated

flush pipe. Closets are set in putty on brass floor flange connected with lead bend, which is calked with brass ferule into subsoil pipe connection. Out of lead bend a lead connection is taken to the 2-inch galvanized-iron revent, which is carried to stack and extended above roof. All water pipe is galvanized iron. Bath tubs and slop sinks are of first-class enameled iron. Showers are tubular, of tinned copper. Enameled iron basins were generally used. Urinals were generally of the porcelain lip type and sometimes enameled trough with automatic flush.

Where electric lighting was done, the rules laid down by the Underwriters' Association of the United States were closely followed.

In kalsomining, the walls were thoroughly scraped with ship scrapers and covered twice with a wash composed of water, lime, color, and either tallow, zinc, or oil. The woodwork, after being thoroughly scraped, was covered with white lead ground in linseed oil, colored. The walls of some rooms in the more important buildings were tastefully decorated.

Masonry work, like carpenter work and other work requiring skilled labor, is exceedingly expensive, and though the natives do their work thoroughly, they are very slow. The sand of this locality is of poor quality. The lime, though plentiful, is very liable to be air slacked and full of clinker. Quicklime should be slacked two weeks before using. Most of the new brick and stone walls have been laid in 1 to 5 Portland cement mortar; the local so-called "Cuban cement" lacks uniformity. The brick on the market is of variable size and very poor quality. Building stone is porous and soft. Good hard flint stone for concrete is plentiful.

Concrete floors are constructed of 3 inches of concrete of Portland cement mortar mixed with sand and rock in proportion of 1 part cement, 2 parts sand, and 5 parts broken stone, topped with a finish coat one-half inch thick, of mortar composed of equal parts of Portland cement and sand. Tile floors are laid in a one-half inch bed of mortar on well-tamped sand or coco base.

A system of daily reports and records has been inaugurated, whereby the detailed cost of any class of work is arrived at, whether done by the Government forces or by those of contractors, which reduces approximations, in estimates of cost, to the minimum. The following is a schedule of approximate costs of several classes of work in Habana, which are safe for estimating purposes:

| | |
|--------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Excavating and hauling, per cubic yard..... | \$0.70 |
| Brick masonry laid in Cuban cement, per square yard..... | 15.00 |
| Brick masonry laid in lime mortar, per square yard..... | 13.00 |
| Portland concrete masonry, per cubic yard..... | 9.00 |
| Mortar per cubic yard: | |
| With lime (2 sand to 1 lime paste)..... | 5.00 |
| With Cuban cement, 3 to 1..... | 9.50 |
| With Portland cement, 3 to 1..... | 13.50 |
| With Portland cement, 1 to 5..... | 10.00 |
| Brick, per cubic yard..... | 7.50 |
| Ordinary carpenter work, in place, per 1,000 feet B. M., according to class of work (lumber at about \$30 per 1,000 feet B. M.)..... | 40.00-70.00 |
| Concrete floors, per square foot ($3\frac{1}{2}$ inches concrete, one-half inch cement surface)..... | .20 |
| Expanded metal plaster, per square yard (includes metal, plaster, and labor)..... | 1.50 |
| Doors and windows, per square foot (either glazed or with solid panels)..... | .50 |

| | |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Tile roofing (includes rafters and sheathing), per square foot | \$0.26 |
| Scraping, per square yard, from | .03-.10 |
| Plumbing installed, including all piping: | |
| Ordinary water-closets | 60.00 |
| Baths | 70.00 |
| Enameled iron sectional basins | 30.00 |
| Showers (separate) | 20.00 |
| Trough urinals, per linear foot | 18.00 |
| Detachable iron basins | 38.00 |
| Sewers: 4, 6, and 8 inch vitrified pipe or cast-iron soil pipe, including appurtenances, per linear foot, about | 1.00 |
| Electric-light wiring and fixtures, per light | 10.00-14.00 |
| Ordinary painting (three-coat work), per square yard | .30 |
| Kalsomining (two coats), per square yard | .06 |
| Tile floor, per square yard (includes coco base, mortar bed, and tile) | 1.50-2.50 |
| Water-tube boilers, per horsepower, in place | 30.00 |
| Dynamos, per kilowatt, in place | 35.00 |
| Compound condensing engine, per horsepower, in place | 35.00 |
| Structural iron work, excessively high, averaging per pound, in placo, about | .12 |
| The renovation of public buildings costs, per cubic foot of contents, below the eaves as follows: | |
| Compostela street orphan asylum | .03½ |
| Old post-office building | .06 |
| Belascoain barracks | .02 |
| Hospital Militar: | |
| With iron work | .07 |
| No iron work | .05 |
| Cost of building of tile roof, wooden truss, expanded metal plaster walls, brick piers, concrete floors, per cubic foot | .15 |
| Ordinary warehouse buildings, corrugated iron roof, wooden truss, wooden floors | .09 |
| Buildings fitted up for hospital purposes, having tile roof, novelty siding, inside ceiling, wooden floors, 2 feet of ground, supported by piers, surrounded entirely by porches, cost, per cubic foot ... | .13 |
| Cost of disinfection, per 100 square feet (labor, \$0.06; bichloride of mercury and hydrochloric acid, \$0.12) | .18 |

This department has repeatedly done work at a much less cost than prices obtainable from the local contractors. This due principally to the superiority of organization and the margin of safety and large expectation of profit figured on by contractors.

OLD POST-OFFICE BUILDING.

The eastern part of this building was occupied by the U. S. Navy, and the western end by the U. S. Signal Corps and the cable office. The portion occupied by the Signal Corps and the cable office was renovated by this department. This building was in an especially unsanitary condition. On the upper story of the balcony of the rear patio latrines were located with channels leading through the walls to a large cesspool below, which, when uncovered, was found to contain about 300 cubic feet of fecal matter. The walls in the rear patio were stained by years of contamination, and in fact the foulness permeated the entire structure. That portion of the building in the rear patio was entirely demolished and burned, and the walls were scraped to the bare stone, and scraping was done throughout the building. Disinfection was carried on so systematically that, notwithstanding the fact that the building is known to have harbored cases of yellow fever in preceding years, no cases occurred during the repairs or after their completion, although the building was occupied continuously by

nonimmune employees of the signal service and cable office. The entresuelo of the south side, being rotten, was removed, and a well-lighted and roomy storeroom made. New concrete floors were laid throughout the lower floor, except where marble tile existed. The floor beams being formed of the splendid acana wood, the paint was scraped from them to expose their natural beauty. The beams of the balcony of the inner patio had to be replaced by sound timbers, necessitating much incidental work. The cornice molding was renewed all around the patio. A new stairway was erected to entresuelo. The entire floor of the entresuelo was relaid, the broken tile being replaced by tile from the upper floor. On the upper story marble floors were laid, and a great deal of mosaic tile was also laid. The roof was found to be in a very bad condition, and two-thirds of it had to be renewed. The condition of several partitions necessitated their renewal. A new room was constructed in the rear hall. In the rear patio on the second floor, on the north side, a toilet room was constructed, and on the south side a bathroom, the two being connected by a balcony. The construction was of iron columns and I beams, obtained from La Fuerza. The floors were of tile and the sides of wooden louvre work; the roof of French tile. Sewer connection was made to street sewer, with cast-iron soil pipe. The plumbing consisted of 5 syphon jet closets, 4 lip urinals with automatic flush tanks, 2 oval marble basins, 1 enameled iron-roll rim slop sink, and 2 copper tubular showers. The material was furnished at a cost of \$531, and the labor was performed at a cost of \$240.

Electric light and gas were installed throughout. Electric lights, of 16-candlepower each, consisted of 23 1-light brackets, 1 2-light bracket, 1 4-light chandelier, 10 3-light chandeliers, 32 2-light chandeliers, 4 1-light chandeliers, 4 1-light pendants, 1,200 feet five-eighths-inch iron armored conduits, 800 feet three-fourths-inch iron armored conduits with necessary couplings, elbows, tubing, switches, distributing boards, and 5,250 linear feet of wire. Iron grating was placed at the main south door and at the intersection of the large south room with the rear patio. This work was commenced in June and was finished in September.

HOSPITAL MILITAR.

Early in January, 1899, this building was cleaned and disinfected with quicklime and chloride of lime. Several outbuildings were burned to the ground and the premises were not used for any purpose until the latter part of June, when the long cell room on the harbor side of the building, formerly used for insane Spanish soldiers, was converted into a dog pound. This building bears an exceedingly bad reputation from a sanitary standpoint, and the advisability of using it at all received serious consideration from the authorities. Samples of the plaster, taken from the walls in the worst part of the building, were given to the medical department for bacteriological tests, report being that no dangerous bacteria were found. After an exceedingly thorough disinfection, it was decided that the building was perfectly safe. It has been stated that, during the Cuban revolution, something like 20,000 Spanish soldiers died here of yellow fever. If this is a fact, the efficiency of the system of disinfection employed by the department is established beyond a doubt, for, during the disinfection of this build-

ing, many nonimmune Americans were employed, and not a single case of sickness developed. The walls and floors were first washed thoroughly with electrozone sprayed under pressure by force pumps, every particle of exposed surface being gone over twice with this disinfectant, and afterwards bichloride of mercury, mixed in the proportion of 1 to 400, was similarly sprayed over the entire building.

This is a large two-story building, situated in front of the Tallapiedra Wharf and having a frontage of 588 feet on Diaria street and 310 feet on Factoria and Revillagigedo streets.

It having been decided upon as a fit building for transformation into a city prison, orders were received September 8, 1899, to prepare plans and estimates for this work. The Hospital Militar is an old building, but in an excellent state of preservation. Built on a plan typical of this country, the structure proper extends around a large court, which is divided by another building extending the full width of the court. The courtyard is made attractive by a luxuriant growth of flowers, vines, fruit trees, etc., which are kept in good condition. The estimate amounted to \$121,880, and the plans as approved provided accommodation for 1,000 prisoners and embraced steam kitchen, steam laundry, hospital wards, work rooms, administration offices, apartments for warden, deputy warden, officers and guards, and machinery for a complete electric-lighting plant; for installation of 10 modern steel prison cells; for setting new steel guards and doors in all openings in building; for a modern plumbing and sewerage system; for general remodeling work, including mason work, carpenter work, structural iron work, new floors, skylights, ventilators, etc. The estimate was approved and \$10,000 more provided for scraping, whitewashing, painting, etc. Thirty-five thousand dollars, an amount previously allotted to remodel the present city carcel, was transferred on May 1, 1899, for work at the Hospital Militar. The remaining \$96,880 was to be furnished in equal monthly allotments. Previous to January 1, 1900, \$8,620.89 was expended for purchase of material, disinfection, etc. Work proper began, under the supervision of Mr. Fred W. Piel, on January 9, 1900. The system of disinfection previously commenced was renewed. Spray pumps and sprinkling cans were used in applying the disinfectants, electrozone, bichloride of mercury, and chloride of lime. During the time that the work was in full progress an average of 500 gallons of electrozone per day was used.

Contracts were awarded as follows:

| | |
|--------------------------------------------------------------|-----------|
| Electric-lighting plant, to Newhall Engineering Company..... | \$24, 350 |
| Steam laundry, to American Laundry Machinery Company..... | 4, 000 |
| Steam kitchen, to John Van Range Company..... | 4, 302 |

Bids were received for the work of furnishing and installing 10 steel cells and steel guards throughout the building. It was the intention to install 10 cells of the most modern type, with exercise corridor, etc., the idea being to provide a sample of a modern prison cell that might be followed in the construction of future jail buildings on the island. Similar cells were to be added to this prison as funds might become available. The Van Dorn Iron Works presented the lowest bid, the amount being \$40,783.50. The contract was about to be signed when orders were received to stop all work at the hospital. This same order prevented the signing of a contract with Messrs. Purdy & Henderson, amounting to \$17,624, for installing a system of plumbing, tender for which had been received. The disposal of sewage at the hospital pre-

sented a problem on account of the slight fall obtainable, the greatest average fall that could be secured in the sewer line to be extended to the bay being 0.8 per cent, and, furthermore, to secure this fall it was necessary to lay the sewer pipe at a depth that would allow the water to back up in the sewer for a distance of about 200 feet at high tide. It was believed that a better method of disposal would be to conduct the sewage through a sewer laid at a grade of one-eighth of an inch to the foot into an iron tank of sufficient capacity to contain sewage of twenty-four hours of 1,000 people, and to discharge same by compressed air into the night-soil scow, to be transported out to sea, an outlet being provided for forcing sewage into harbor when conditions so demanded. The Stillwell, Bierce and Smith Vail Company offered to furnish this apparatus complete for \$1,400. It was concluded that the night-soil scow facilities were inadequate for the transportation. The matter was referred to Mr. Samuel M. Gray, consulting engineer, then engaged in other work for the engineer department. Mr. Gray decided against the tank system, and recommended that the sewage be conducted through three 6-inch branch sewers laid to a grade of 1.25 per cent to a point about the middle of the south side of the building, where they would discharge it into a clean-out box, the same to be properly vented. An 8-inch sewer laid to a grade of 0.35 per cent would conduct the sewage from this point to the bay, a distance of 365 feet, entering the bay at a point 1 foot below high-water line. A back-water valve was to be placed on the 8-inch outlet immediately after leaving the clean-out box, and on bay side of valve a flush pipe leading from a 500-gallon tank, to be placed on roof, was to be connected. The 8-inch pipe was to be flushed twice daily at low tide when the sewers would be free from tide water. The recommendations were adopted and the sewer installed accordingly. The rain water was taken care of by two surface drains graded from points about the middle of the north side of the courtyard and extending around the four sides of the courtyard in opposite directions, entering 8-inch drains at a point near the middle of the south side of the building. Through the 8-inch drains the water is conducted to a 12-inch drain that leads to the bay. Before the order for abandonment was received the work of remodeling was carried on as rapidly as possible. All decayed woodwork was removed, new door openings were cut and old openings were built up in the heavy masonry walls. Partition studding was erected and new floors laid. A large amount of surface area was covered with plaster, and old roof tile replaced by new tile in several places. In compliance with orders received, all work, excepting the installation of the sewers, surface drains, and the work of completing alterations of such character as could not be left unfinished, was stopped February 23, 1900. As the building stands to-day, nearly all the work of repairing woodwork, floors, and walls on the second floor has been completed. On the first floor all work of cutting new door openings, closing old ones, patching and plastering walls, has been completed. Sewers have been installed, surface drains built, a considerable amount of stone flagging has been graded and relaid, and rooms that were to receive the boilers and machinery were enlarged by removing two large masonry walls and supporting roof above on trusses. The laundry machinery and steam-cooking outfit were installed at the Casa de Beneficencia and the electric-lighting plant is being installed at the Cuartel de la Fuerza by the chief engineer, Division of Cuba, to light the governor-general's and lieutenant governor-general's palaces.

The following is a financial statement to June 30, 1900:

| | | |
|----------------------------------------|-----------|--------------|
| Total allotment | | \$104,000.00 |
| Transferred to Beneficencia | \$500.00 | |
| Transferred to Fuerza Electric | 29,350.00 | |
| Transferred to treasurer | 31,155.48 | |
| Transferred to treasurer | 16,500.00 | |
| | | 77,505.48 |
| | | 26,494.52 |
| Requisitions | 9,075.18 | |
| Hauling | 176.85 | |
| Reimbursements | 104.51 | |
| Labor | 11,424.06 | |
| Draftsmen | 2,155.00 | |
| Live stock (2 mules and 1 horse) | 450.00 | |
| Freight and duty | 640.88 | |
| Contracts (Compostela \$850.83) | 870.83 | |
| Stationery | 46.00 | |
| | | 24,943.31 |
| Balance June 1 | | 1,551.21 |
| June expense and labor | | 117.50 |
| Balance | | 1,433.71 |

MILITARY STABLE.

The lot at the southwest corner of Zulueta and Genios streets, being the only available location for a stable for the use of public officials, plans, specifications, and estimate were prepared in compliance with orders received. The project was for a stable for the accommodation of 12 horses, with space for 6 carriages, office, feed room, coachman's room, and a bath trough for horses' feet. The limited funds available for this building made it necessary to abandon the idea of constructing the building of masonry; and yet it was essential that the stable should be at least semifireproof. Comparative estimates of cost of different materials resulted in the selection of expanded metal and cement mortar as the principal materials to be used in the construction. These materials filled the requirements satisfactorily. They possessed fireproof qualities, could be so used as to present a pleasing aspect, and their use represented a saving of over 20 per cent on the cost of masonry construction. The building as built consists of brick piers averaging 13 feet on centers; construction between piers is of 2 by 4 inch studding, expanded metal lath, and lime and cement plaster; large window and door openings were provided between piers on three sides of the stable, and wooden trusses for support of roof span of the building rest on the brick piers. The roof is of tile with a one-third pitch, with an overhang of 14 feet at each end and 9 feet on sides. A louver ventilator extends along the ridge of the roof. The floor of the stable is of cement. Plumbing fixtures were installed and modern stable fittings provided. Bids for labor being unsatisfactory, the construction was commenced by Government forces, in charge of Mr. M. M. Latta, on November 23, 1899. Excavations for foundations exposed compressible material, and were made to a depth of 12 feet instead of 3 feet, as originally contemplated. Progress was retarded seriously by the inability to secure iron material, which was finally obtained at a very exorbitant, but best obtainable, figure. The exterior of the building was ornamented with neatly run cement moldings. Spar varnish was applied to all exposed woodwork inside and outside. Electric-light

fixtures and electric bells were installed and every detail calculated to make this stable a modern one in every respect received attention. The cost of this building was \$11,761.10. In its construction surplus materials, such as rock and brick from other work in charge of this department, were used, and a portion of the ironwork was obtained at the Fosos and fashioned by the prisoners at the Presidio. Had all the materials used in the construction of the building been purchased at market prices, the cost would have been \$13,290.36. The type of construction employed on this building has many features to recommend its extensive use in this climate.

COMPOSTELA STREET ORPHAN ASYLUM.

This structure was formerly the barracks of the Spanish light artillery, and occupies almost completely the entire square bounded by Compostela, Fundicion, Picota, and San Isidro streets, covering about 2 acres, and having a frontage of 650 feet on Compostela and Fundicion streets. Inside the area included by the wings of the main buildings and the fence walls there are three two-story stable buildings, a large one-story building, and a kitchen shed along the wall.

Early in the year 1899, the building and premises were renovated as a sanitary measure, considerable repairing being done. It being decided not to quarter United States troops there, the premises were occupied by the families of indigent widows. Plans and estimates were prepared in May, 1899, to remodel the structure to accommodate 200 girls and 260 boys, at a cost of \$27,000. Work commenced in the second week in June and was substantially completed in sixty days, notwithstanding that much delay was occasioned by tardiness in delivery of material. The lower floor of the main building had been divided by partitions into small apartments. These were all torn out, and the lower floor devoted to schoolrooms. Similar partitions were removed from the upper floor, which was converted into dormitories for the girls. The upper floor of the rear wing was arranged for attendants' apartments. The upper floors of the three large stable buildings were converted into boys' dormitories. The mangers and cobblestone floors in the stables were removed, and in two of these buildings pine floors 3 feet above the surface of the ground were constructed. In the other building concrete floors were laid. The former two were converted into boys' shops and play rooms; the latter into a dining room for boys. The old kitchen was completely rebuilt in the remaining large building; and area was remodeled for girls' dining room. A boys' toilet room was placed in the lower floor of the rear wing of the main building in close proximity to their dormitory and play room. The girls' toilet room was placed in that small part of the main building fronting on San Isidro street. Emergency toilet rooms were placed near the girls' dormitory and in a room at the rear of each of the boys' dormitories. The third story at the corner of Compostela street was remodeled for boys' and girls' hospital, with toilet rooms immediately below. Private toilets were provided for attendants. Thirteen concrete tubs were placed in the laundry. The three stable buildings were in an exceedingly bad condition. The following statement of details will, in a small measure, convey some idea of the scope of the work: Bowlders were removed, ground graded, mangers demolished and burned, concrete floors were placed in the two rooms used for boys' baths, in shed kitchen, in the large rooms used for boys' and

girls' dining room, and in the girls' toilet room. Tile floors were placed in old kitchen on the third floor, in four large rooms on Fundicion street, and at every point where partitions had been removed, the unevenness of the floors making this necessary. On the balcony of the third floor stone slabs were laid in boys' wash room and closet rooms. Bowlders were relaid in old blacksmith shop converted into storeroom located near kitchen. The main entrance was originally paved with flagging. These were removed and replaced with marble tile obtained from the principal rooms above; the depression in the floor demanded a renewal. The marble tile were in turn replaced by mosaic tile. Much work in relaying tile was performed in the main balcony. The kitchen room was practically rebuilt, as was also two-thirds of the laundry room. The roof over the girls' dining room required no little expense. Ten doors missing on third floor were replaced; 196 doors were used to close openings of the boys' dining room. Doors were also necessary in boys' emergency toilet room. Five windows were inserted on the third floor. Skylight ventilators were built in the roof of the girls' dining room. Seventy-six windows of the upper story of the old stable buildings or boys' dormitory were, with their casings and frames, entirely renewed. Sixteen steps lead from new floors of the boys' shop and play rooms to ground. The floors of the stable balcony were entirely relaid, as was a large portion of the boys' dormitory proper. One stairway was torn out on Compostela street and the hallway added to the length of schoolrooms. Stairs to roof from second floor were repaired. Three winding stairways to Fundicion street were torn out. Spiral stairway was erected to laundry roof. Main stairs to boys' dormitory from patio were completely rebuilt. Bridges were constructed to connect the three boys' dormitories with covered stairways leading to toilet rooms below. Locks and fastenings were placed on every door and window in the building. One-third of the blinds on Compostela street were repaired. Blinds were constructed for all new openings. Two-thirds of the blinds of the main balcony were either replaced or repaired. This represented a considerable part of the total expenditure. Balcony of third floor, corner of San Isidro and Compostela streets, was entirely renewed. Girls' hospital toilet room on second floor is a new structure. Fifty-eight partitions were torn out on the first and second floors and one on third floor. One brick partition was built at boys' closet. The water table of the three stable buildings was replaced. Four new openings on Compostela street were cut, also one at girls' hospital toilet. Six doors on Compostela street were replaced by windows.

The plumbing consisted of the following: Girls' toilet, 15 water-closets, 3 bath tubs with showers, 5 showers, 17 basins; girls' and boys' hospital toilet, each 1 bath, 2 water-closets, 1 slop sink, 2 basins; four boys' and girls' emergency closets, each 1 bath, 1 water-closet, 1 bowl, 1 slop sink; boys' toilet, 25 water-closets, 20 linear feet trough urinals, 25 wash basins, 15 showers.

Main sewer was 8-inch vitrified pipe with 4 and 6 inch soil line branches to different toilet rooms. The court yard was graded to secure drainage. It might be pertinent to add that later the court yard was covered with concrete floors, steam kitchen installed, additional water supply and toilet rooms provided, shelving and refrigerators built, electric-light plant installed, by forces employed directly by the department commander.

Mr. C. C. Converse was in charge of all this work.

CABAÑA.

The present carcel of Habana and the presidio of the island is located in a very large edifice at the foot of the Prado immediately opposite Morro Castle. This splendid location, combined with the ease with which the structure could be altered to suit the requirements, made it desirable for a public office building, to which end the carcel was to be transferred to the Hospital Militar and the presidio to Fort Cabaña. That the design of these prisons might follow the lines of the most recent practice, Captain Huston, while in the States, visited several of the large penal institutions to obtain required data. Preliminary plans and estimates were prepared for the conversion of Cabaña fortress into a penitentiary to accommodate 1,200 prisoners. The casemates were to be floored with concrete, ventilated and lighted by openings at ends and by ventilators through roof, and provided with closets, basins, and urinals. The majority of these casemates were each to be occupied by about 40 prisoners and the remainder to be used as shops, storerooms, etc. The large building opposite the main entrance was to be arranged for administration offices, guards' quarters, and women's prison. The present officers' quarters were to be converted into wardens' apartments. Dining room, steam laundry, and steam kitchen were to be located in south casemates. A high-class electric-light plant was to be located in the south end of the central moat, from where an inclined railway was to run to the harbor. Sewer was to lead to sea at a point east of Morro Castle. A new hospital building located on central ravelin, where the prospect is pleasing and the breezes refreshing, was contemplated. It was expected to erect 100 tool-proof steel cages for desperate characters, with the understanding that the prison management would equip the prison with tools to continue the installation of cages and finally arrive at a complete individual confinement. The estimate was \$236,222, but has not been allotted as yet.

WIDOWS' HOME.

This is a large two-story stone building situated at the southwest corner of Belascoain and Estrella streets and serves as home for a number of widows and their children. In February, 1899, work of absolute necessity only was performed in cleaning sewers, which had been entirely clogged with fecal matter, and in repairing plumbing, in which there were leaks that permitted sewage to flow over the floors. No thorough attempt at renovation had been made until orders received December 1, 1899. The building was visited and inspected, and was found to be badly in need of a general overhauling. A portion of the plumbing work and fixtures in the building were found to be in good condition, but most of the plumbing and all of the sewers were in a condition that endangered the lives of the inmates. All the soil and waste from the building emptied into cesspools under the yard. The condition of the building was reported and funds were allowed sufficient to cover the expense of the sanitary improvements only. The old cesspools in the building were cleaned, disinfected, and filled with clean earth. Five hundred and thirty-three feet of sewer pipe was laid, 23 water-closets, 5 bath tubs, and 5 sinks were installed, and 9 cement laundry tubs built. A tank was placed on the roof and the water supply increased. Plumbing was concentrated at three points. The drainage of the roof and yards was per-

fect. One hundred and thirty rooms in the building were repaired, painted, and whitewashed. Gas pipe was renewed in some of the rooms, sky-lights constructed on roof, and a large amount of stone pavements taken up, graded, and relaid.

Alexander Roger was foreman in charge of this work.

ABATTOIR.

The pollution of Matadero Creek by the offal from the slaughterhouse renders that rivulet a menace to the health of the community and makes the construction of a modern abattoir, or at least an offal disposal works, a matter of sanitary necessity. The subject has received the attention of this department, modern abattoirs having been visited, data collected, and preliminary plans made, and several large firms in the United States have plans, estimates, and propositions ready for submittal. At the Habana abattoir at present, the bullock is let into the slaughterhouse from corrals, lassoed, and tied to a pile driven into the ground for that purpose. The butcher sticks him in the back of the neck and cuts his throat when he falls. The blood flows into a central drain and runs into Slaughterhouse Creek. The bullock is raised by both hind legs, by means of ordinary block and tackle, his hide and entrails removed, and the dressed beef is carried to butcher wagons in the streets. No systematic disposal of entrails is attempted, and a considerable portion goes to pollute the Slaughterhouse Creek near by. There is no cold storage and the rendering pots are crude in the extreme. No system of overhead carriage is employed. While the buildings and grounds are kept exceedingly clean, the system is a menace to the health of the community. The modern abattoir is of two or three stories, and, this question of height being an essential one, the complete remodeling of the entire structure appears a necessity. In the modern abattoir the cattle are driven by chutes to top story, to a narrow passage way parallel with dressing beds. The killer stands in a passage way on the opposite side at an elevation a little greater than the bullock's head, and kills by a blow on the forehead with a piked axe. The gate is raised vertically and the bullock rolls over onto dressing room floor, located about 18 inches below. He is generally suspended by both hind legs by means of friction hoist. His throat is then cut, the blood running into a drain. By the Jew or "Kosher" method, the bullock is roped by his hind legs, elevated by friction hoist, and while dangling alive, but helpless, his throat is cut horizontally. The cut is inspected by a Rabbi at hand to see that the killing was "Kosher." The blood is carried to a steel tank and is cooked to a consistency of putty, drawn off, and shoveled into drier on floor below, from where it comes out a valuable fertilizer. The hide is removed and thrown into a chute to the hide room to be cleaned, salted, and sorted. The head is cut off and passed to another hand, who removes the tongue and brains, which are sold in open market. The horns are sold to manufacturers of horn and tortoise-shell goods. Shin bones are removed, the best parts of which are sold for knife handles, brush handles, buttons, etc. Hoofs are used in the manufacture of neat's foot oil. Entrails are removed and dropped upon the floor. The paunch is cleaned of manure, which is shoveled into a chute to be delivered easily to farmers' wagons. The paunch itself is dropped to the floor below, washed, steamed, and pickled for tripe.

The "long fat" is cut off of intestines and sent either to oleo oil plant or to rendering tank. If over 200 head are killed per day, it is economy to have an oleo plant, the product having a ready market in Europe, to where shipments are made from the United States. The largest and best of the intestines are washed and used for bologna-sausage coverings. The remaining entrails, after being washed, are conveyed to rendering tank and cooked by steam into tallow. After drawing off the tallow, the residuum is emptied into drier, and comes out a marketable fertilizer worth now \$22 per ton. All tobacco-growing countries afford a ready market for this product. The dressed beef, cut in halves, is transported by overhead trolleys to cold-storage rooms, generally located on floor below. The cold-storage system is very essential to a well-regulated abattoir, and should by all means be put in. For the extraction of oleo oil, the "long fat" is conveyed through a "hasher" to cast-iron rendering kettles, drawn off into "seeding truck," and allowed to stand until the consistency of putty, when it is put into canvas cloths and pressed by hydraulic press, leaving an oleo oil, the residuum being stearine, which is used for candles, etc. The power plant must consist of pumps, shafting, and pulleys to operate friction hoist and elevators, electric-light plant, steam laundry (to secure clean clothes for operators), rendering tanks, drier with boiler plant of sufficient capacity, cold storage, and ice machinery. An immense amount of water is consumed in an abattoir, and is no small item. For a municipality to operate an abattoir is no more of a venture than operating its own waterworks. A modern abattoir should be erected, because (1) it is the cheapest mode of killing; (2) the reducing process is not only the cheapest, but is a very profitable way of disposing of the offal; (3) it will remove completely the present contamination of Slaughter-house Creek; (4) it will exhibit to the community a sample of American high grade economical machinery in its highest development; (5) cold storage should be adopted for sanitary reasons; (6) it will only be a question of time when a modern abattoir will be built, and any money spent on repairs or partial improvements will be wasted. A modern abattoir for Habana will cost in the neighborhood of \$200,000.

CUSTOM-HOUSE.

Work at the above place ceased during the first week of August, on account of funds not being allowed. Very little of this exceedingly large building has not been cleaned, whitewashed, or painted by the forces of this department.

CASTILLO DEL PRINCIPE.

Expenditures at this fort were for preparation and commencement of renovation for the occupancy of two companies of infantry, but work was stopped and the fort turned over to the chief quartermaster, Division of Cuba, for storeroom.

SWINE SLAUGHTERHOUSE.

During the month of March complete plans and specifications, with estimate, were prepared for improving the sanitary condition of and building an addition to the Habana matadero; the addition to be used

as a slaughterhouse for swine. Bids were invited and received from local contractors; the lowest bids being, for—

| | |
|-----------------------------------|--------------|
| Plumbing | \$2, 877. 77 |
| Cement floors, per sq. yard | 1. 90 |
| Masonry work and plastering | 1, 189. 00 |
| Carpenter work | 4, 362. 75 |

The contracts for the plumbing, cement floors, and masonry were awarded. The bids received for carpenter work were considered excessive and permission was obtained from the military governor to allow this portion of the work to be done by government forces. Work was begun on May 3, and was practically completed on June 30. The improvements consisted of general patching of cement floors, building a new toilet room containing 7 water-closets, 3 urinals, and 2 wash basins. A new 8-inch cast-iron drain was extended under the cement floor through the middle of the slaughterhouse. Thirty-four self-closing cocks and 2 reels of 2-inch fire hose, each 75 feet long, were provided. New open drains were built around three sides of the group of buildings comprising the slaughterhouse and corrals. Seven hundred feet of sewer pipe, ranging from 6 inches to 15 inches in diameter, were laid. A shower room containing 30 showers was built, and an extension was built covering an area of 4,100 square feet. Part of this extension was fitted up as a swine slaughterhouse, containing overhead track, travelers, cleaning tank, scalding vat, assorting tables, conveyers, shacklers, etc. New cement floors were laid and swine corrals were built and provided with water troughs, etc. The cost of the work done by the government forces was about \$1,200 less than the amount of the bid presented by the contractor who was lowest on this work.

MUNICIPAL VIVAC.

The ordinary style of earthenware water-closet was found to be entirely too fragile to stand the hard usage they were subjected to by the prisoners at the vivac. After being in use two months, examination showed that nearly every closet in the building had been loosened at the floor connection; the seats of many had been wrenched off, and one closet had been wrenched from its fastenings and broken into pieces. These facts indicate the necessity for installing closets of a special pattern constructed particularly to withstand hard treatment in Habana prisons. At the vivac it was found necessary to provide water-closet accommodations for the public, and a room was fitted up for this purpose with 4 water-closets and 4 urinals. In other parts of the building 4 additional urinals were installed, 3 water-closets which had been rendered useless replaced, and general improvements made, consisting of installing iron gratings, wire-mesh window guards, cement floors, expanded metal plaster partitions, reinforcing floor connections of all closets in the building, and setting up a new flagstaff.

REINA BATTERY.

On January 19, 1900, orders were received to remove all the inmates of the Asilo de San Jose to the Reina Battery. All portable articles were moved to the new quarters and cots were cleaned and renovated by live steam. At the battery, two high fences were constructed across runways leading to top of casemates. Also a new set of cook-

ing utensils was furnished. In February orders were received to install incandescent lights, arc lights, portable cabinet and closet, and to furnish clothesline on which blankets could be hung and aired. 35 incandescent lights, 2 arc lights, and 3 water-closet cabinets were installed. On April 5, 3 new showers were installed. The battery is laid out on a circular plan, inclosing a large court that affords an excellent playground for the inmates of the asylum (who are refractory boys). Sleeping quarters are provided in the casements.

Expenditures for the current fiscal year at the Santa Clara Battery, Dragones Barracks, Belascoain Barracks, Punta Barracks, and Maestranza de Artilleria were for unpaid bills pertaining to the preceding fiscal year.

GOVERNOR-GENERAL'S PALACE.

In many respects this is one of the finest buildings in the city. From an architectural point of view the exterior has many points to commend, while the carving on the marble at the main entrance is of a character rarely seen. The heavy acana and jocuma floor beams in the interior construction and the general appearance of massiveness present an interesting aspect. The work began in April, 1899, and consisted of remodeling the entire southwestern portion, embracing a large entrance hall and 29 large rooms occupied by the mayor, the ayuntamiento, and the other city officials, who continued to occupy the building during the work of remodeling, which materially retarded the work. The work, with the exception of a few minor details, was completed on January 1, 1900, and consisted generally of cleaning and renovating, installing new plumbing system, new electric-light wiring throughout, with fixtures, piping building for gas and furnishing fixtures, laying new tile floors throughout, cutting openings in first story to increase light and ventilation, furnishing new stair rail and newel posts, general carpenter work, painting and decorating throughout, much lathing and plastering. Plumbing fixtures were installed in the building as follows: 17 water-closets, 14 wash basins, 19 urinals, 3 slop sinks, and 2 showers.

A high class of plumbing was secured at this building by rigid inspection, the finest quality of fixtures being installed. All exposed pipes and fittings are nickel plated. Water-closet partitions are of marble with doors of native wood. The rooms on the first floor have been converted into large and well-lighted offices by cutting arched openings in the heavy masonry walls.

Credit is due to Mr. M. H. Moore, decorator, employed in this department, for the neat decoration of this portion of the palace, the colors throughout being well selected, and the decorative work in the mayor's room having a particularly pleasing effect. A wainscot, 6 feet in height, of a beautiful native wood known as majagua, set in panels and artistically molded, extends around the room. All electric-light wires extend from a switch board on the second floor to different points in the building, where they terminate in heavy brass combination electric and gas fixtures. Carpenter work covered every detail of repair. Fifty Spanish cedar doors were made and hung, tastefully carved newel posts and rail of Spanish cedar were installed, and a large amount of slat partitions erected. Mr. M. M. Latta was general foreman.

OFICIOS STREET CLEANING.

The present system of house to house cleaning and disinfection was commenced by this department on September 2, 1899, the medical department being represented by Major Turnbull. The work was pushed vigorously with over 100 men, requiring 3 large sprinklers to furnish sufficient electrozone. Generally at each house the walls and ceilings were brushed down, the floors swept clean, all rubbish and débris removed from premises and hauled to dump or burned at Tallapiedra wharf. All accessible areas were drenched with fresh electrozone. In all cesspools, closets, and drains chloride of lime was used, and in some bad places, carbolic acid. Where yellow fever was known to exist, cleaning and disinfection were done with special thoroughness, and fumigation by sulphur was also employed. Very little trouble was experienced from tenants, who seemed to view the work as one of necessity, and but few grumbled over the inconvenience to which they were unavoidably put. A total of 107 houses were thus treated.

SHED ROOFS AT BATTERIES 3, 4, AND 5.

These sheds were constructed for the purpose of shade, as the batteries are located along the beach in front of Vedado, and the sun shines on them relentlessly all day. They were constructed over the quarters, the new roof being raised about 1 foot over the roof of quarters, which was done to create a draft between the two roofs. They were extended over the present buildings, projecting about 10 feet each way, furnishing ample shade to the buildings at all times. There were 5 sheds constructed at Battery No. 3, and the work was done under contract by J. C. Champagne for \$13.58 per 1,000 feet B. M. Sheds at batteries Nos. 4 and 5 were built by this department, at a cost of \$7 per 1,000 feet B. M., and consisted of 4 sheds at Battery No. 4, and 5 sheds at Battery No. 5. This work was under the supervision of Mr. J. L. Young.

CASA DE SOCORROS AT CASA BLANCA.

Improvements at this place consisted of converting 3 dilapidated rooms in police station building into an emergency hospital. One room has been fitted up for an operating room, containing an enameled iron sink, another for an anteroom and office, and a third for a bath and closet room, containing one bath tub with shower, one water-closet, and one wash basin. Cement floors have been laid and a sewer extended from the building to the bay, 170 feet distant.

CASA DE SOCORROS, THIRD DISTRICT.

Glass partition built and operating table installed.

INFIRMARY OF PRESIDIO.

The hospital for the accommodation of sick prisoners confined in the presidio is located at the southeast corner of Zulueta and Carcel streets, occupying a long, narrow space, and containing a number of one-story buildings that are used as wards, workshops, laundry, living

and store rooms, administration office, carriage shed, and stable. The grounds are attractive, numerous flower beds and well-kept walks giving the place a very pleasing appearance.

In December, 1899, 850 feet of sewer pipe were laid from sewer on Carcel street, through the grounds of the infirmary to the different plumbing fixtures that were installed. These fixtures were concentrated at three different points, most of which were located in the wards in the south end of the grounds. Closet accommodations were provided, centrally located on the west side of the grounds. Existing laundry tubs, sinks, etc., were connected with the new sewer and properly trapped and vented. The number of fixtures installed were as follows: 8 water-closets, 4 urinals, 1 wash basin, to all of which water supply was extended.

RURAL GUARD BARRACKS AT GUANABACOA.

Work at this building comprised removing fecal matter from existing cesspools, grading yard, and constructing two new masonry cesspools.

PRESIDIO.

At the Habana presidio all the old gas pipe was removed and an entirely new system was installed, pipes being extended to 188 fixtures. In removing the old pipe much of it was found to be almost closed by corrosion.

LAS ANIMAS HOSPITAL.

At the Las Animas Hospital, 187 square yards of tile flooring were laid in the building occupied by smallpox patients.

GENERAL REPAIRS.

Under this heading is included all the special and emergency work of the Department of Habana. This work has been in charge of Mr. Charles Newlin, with headquarters at the Maestranza Building, where a workshop has been constructed. An average of 10 men have been kept constantly employed to meet the demands of this class of work. Against the funds allotted under this heading since July 1, 1899, there has been charged \$4,106.56 for payment of the monthly pay rolls of this office. An idea of the character of the work performed under this heading can be gained from the following:

Repairs at the municipal vivac consisted of installing 3 water-closets and 3 urinals, building metal-lath partitions, constructing cement floors, iron guards, etc. At the third district, Casa de Socorros, glass partitions and operating table have been installed. At Tacon No. 3, window openings have been made to increase light and ventilation. At the governor-general's palace, slat partitions and swinging doors have been constructed. The swine slaughterhouse roof has been reinforced and repaired. At the old post-office, the roof has been repaired. At department headquarters, extensive repairing has been done. At Batteries Nos. 1 and 2, 101 heavy iron locks were placed. New branch drains have been installed at the Tacon Market. Desks, filing cases, tables, drawing boards, bookcases, and cabinets have been constructed, and a vast amount of work in connection with fitting up the different subdepartment offices of the Department of Habana has been performed.

DRAWINGS PRODUCED.

Attention is invited to the work of the draftsmen of this department. Mr. W. O. Ayer, and Mr. Enrique Campi have rendered especially valuable services and assistance in getting out the following drawings, most of which were produced by measurements taken from buildings:

| Drawings of— | Number of sheets. | Drawings of— | Number of sheets. |
|--------------------------------|-------------------|----------------------------------|-------------------|
| Habana matadero | 3 | Rural guard barracks, Guana- | |
| Proposed abattoir | 8 | bacoa..... | 2 |
| Annex to Habana matadero.... | 7 | Carcel, Guanabacoa..... | 1 |
| Beneficencia | 25 | Charity hospital | 1 |
| Carcel | 30 | Recogidas..... | 2 |
| Cabaña | 41 | Tacon Market..... | 4 |
| Dragones street barracks..... | 2 | School buildings | 20 |
| Cuartel de la Fuerza..... | 3 | Palatino pumping station | 11 |
| Hospital Militar (carcel)..... | 131 | Governor-general's palace..... | 23 |
| Quinta de Higiene..... | 2 | Tacon No. 3..... | 1 |
| Presidio | 4 | Reina battery..... | 4 |
| Presidio infirmary..... | 3 | Casa de Socorros at Casa Blanca. | 1 |
| Military stable..... | 37 | Stalls at swine slaughterhouse.. | 1 |
| San Lazaro Hospital..... | 2 | General designs | 20 |
| Municipal vivac..... | 4 | | |
| Widows' Home | 6 | Total..... | 399 |

An average of five blue prints have been taken from each of the above drawings.

A great many reports and estimates on miscellaneous projects were prepared, but not acted upon, among which was: One for bunks at Atares Castle; estimating repairs at the present carcel; a statement of cost of electric-light plant; metal filing device for the ayuntamiento at governor-general's palace; eight cells at Aldecoa Hospital; white-washing Tacon Market; renovating Guanabacoa Orphan Asylum; estimating for additional plumbing at Dragones police station; two rooms on roof at department headquarters; improvement of sanitary condition of Quinta de Higiene; transforming existing swine slaughterhouse into a city stable; repairing tank in tower of custom-house; general repairs at Tacon Market. Plans, specifications, and estimates have been prepared for a pumping station to be erected at Palatino, and to cost about \$8,000. One thousand two hundred trade catalogues, covering almost every subject pertaining to public improvements, have been collected and have been of much value in this city, where we are far removed from the manufacturing centers.

RENOVATION AND REPAIR OF STATE BUILDINGS.—DIVISION OF CUBA.

Capt. T. L. Huston, assistant engineer, in charge from January 15 to June 30, 1900.

The personnel of the assistants consisted of J. L. Young, chief clerk; Paul Wisenall, stenographer; J. G. Scrivener, clerk; D. W. Shea, mechanical engineer; R. E. Moore, draftsman; F. W. Piel, general foreman; George Nicol, plumbing inspector; Alexander Rogers, cost clerk.

WORK OUTSIDE OF HABANA.

BUILDINGS AT COLON, PROVINCE OF MATANZAS.

On January 26, after a trip to that town, a report was made upon the public buildings at Colon, together with a brief description of the

prevailing conditions in that locality. It appears that on July 20, 1899, the assistant state architect made a report and estimate upon a previous report of J. D. Aleshire, major and quartermaster, for the improvement of the carcel, hospital, and conversion of the barracks into an orphan asylum. Following is a comparison of estimates:

| | Hospital. | Barracks. | Carcel. |
|-------------------------------------------|------------|------------|------------|
| Assistant state architect's estimate..... | \$7,600.00 | \$4,016.98 | \$6,378.50 |
| Estimate made by assistant engineer..... | 11,459.30 | 8,463.91 | 7,809.13 |
| Increase..... | 3,859.30 | 4,446.93 | 1,430.63 |

Total estimates, \$27,732.34. Total increase, \$9,736.86.

The increase is occasioned mainly by substituting concrete floors for wooden ones, and by providing ample toilet facilities, to be installed in as sanitary a manner as the absence of a sewer and water system will permit. These buildings were found in the usual dilapidated and unsanitary condition, rendering the improvements desirable.

No further orders were received regarding the matter after submittal of estimates.

PROPOSED BRIDGES ON SAN GIL ROAD, SANTA CLARA.

On February 7 report was made upon bridges on San Gil road, near Santa Clara. Proposed center pier was deemed useless, and a detriment to waterway. Wooden floor system was considered more expedient than that of heavy railroad iron, which burdened span unnecessarily. Cost was reduced from \$907.25 to \$595.

SANTIAGO WATERWORKS.

On February 24 the following estimate was made upon the Bacon Air Lift Company's proposition to guarantee a water supply of 1,000,000 gallons per twenty-four hours for the city of Santiago, the data obtainable being meager:

| | |
|------------------------------------------------------|----------|
| Pumping plant station, etc., complete | \$20,000 |
| 2½ miles 10-inch force main, at \$2.25 per foot..... | 26,700 |

Leaving a balance for drilling wells, profit, etc., which was believed to be too great. The company withheld all vital data. It was recommended that a distribution tank, to cost \$15,000, be added to proposed system, that the system be comprehensively designed to admit of expansion, that a meter system be adopted, and that bids be received after advertisement upon plans and specifications prepared by the engineer department.

REPAIRS TO BUILDING AT BAYAMO.

On March 13 the following estimate was prepared upon scant data obtained from pencil sketch, furnished by Lieutenant Hardeman, of repairs to public building at Bayamo:

| | |
|-------------------------------------------------------------------|---------|
| 51 squares of roof, using old tile, at \$21 | \$1,071 |
| 9 new trusses, at \$75..... | 675 |
| 13 windows enlarged, 60 square feet each, complete, at \$120..... | 1,560 |
| 6 doors, complete, at \$60..... | 360 |
| Total | 3,666 |

GUANABACOA HOSPITAL.

On May 24 an inspection of the Guanabacoa Hospital was made, to verify correctness of request for funds—\$1,470—to make desired improvements. It was recommended that the amount be increased to \$1,670 to permit a proper installation of toilet facilities for the attendants.

This institution was found in an especially clean condition. Plumbing is new, but not revented. Liability to siphonage being slight, expense of reventing was not advised. The sewage is carried into one cesspool, overflows into another, and after fermentation overflows into a large open excavation from which it is pumped by windmill to distant open fields for irrigation purposes.

COLUMBIA BARRACKS HOSPITAL.

Upon the instructions of General Chaffee, chief of staff, Division of Cuba, the plans and specifications for two hospital buildings and bath house at Columbia Barracks, prepared by quartermaster's department, were inspected with a view to suggesting a more economical style of construction. The buildings were well planned, excepting two vital features, location of lavatories in middle of wards and very low ceilings.

To cheapen cost, it was suggested that lavatories be relocated and number reduced, tile wainscoting and floors be discarded, and that length of porches be reduced, \$6,840 being estimated saving. Total estimate was \$19,227.

SANTIAGO SCHOOLHOUSE.

In connection with Lieutenant Hanna, aid-de-camp to General Wood, much consideration has been given the construction of schoolhouses throughout the island, the immediate result of which was the issuing of orders for the preparation of plans and specifications for a schoolhouse in the city of Santiago.

This building is to contain 6 class rooms, 34 by 26 feet, with a cloak room for each class, separate rooms for the principal and for the teachers, and a large entrance hall and vestibule.

The plan of the structure is in the shape of an "I," the portion of the building represented by the body of the "I" being externally 117 feet 4 inches long by 28 feet 8 inches wide, while each wing measures 28 feet by 70 feet 8 inches; the total length being 174 feet 8 inches and the greatest width 70 feet 8 inches.

The height of ceilings is to be 17 feet, and the external height of the walls will be 29 feet.

Special features have been devised for this building. They consist of (1) a porch 7 feet 4 inches wide, surrounding the entire structure; it is covered with a Marseilles tile roof, supported by wooden turned columns. A parapet wall is to be erected on the outside of this porch, forming a base for the columns. (2) A flat roof to be used as a play space for the children of the school, affording an area of over 6,650 square feet, and to which access is given by a stairway 6 feet wide, leading from the entrance hall. The advantages of such a playground are numerous and easily conceived. It is covered by a hip roof of

Marseilles tile, supported by an arched wall, the whole offering protection as well as ample ventilation.

The entire structure is to be built of local limestone, cut and hewn to present a rustic and rather massive appearance; the porch floor being concrete, and yellow pine flooring used inside the building.

The 6 class rooms are to be lighted and ventilated by numerous windows of the Renaissance style, while further ventilation will be afforded by means of openings arranged on two sides of each room at the ceiling, the openings being concealed from above under benches provided with louvre slats.

Each wing is to be divided into 2 class rooms 34 by 26 feet, these to be separated by sliding doors carrying slate blackboards as part of the paneling. Flexible sliding doors will divide the class rooms from the cloak rooms, and in front of these doors there will be other back sliding boards.

All the cloak rooms will be accessible from the porch, being thus amply ventilated.

Another advantageous arrangement is the possibility of reaching under cover every room of the building by way of the well-protected porch.

The principal's and the teachers' rooms and two schoolrooms will open into the entrance hall, and the large stairway to the roof, already referred to, is situated in this hall.

Closets are to be placed in well-arranged, isolated buildings. Sewage disposal will be effected by septic tank and filter beds.

The design of this building was carefully considered by the chief engineer and division commander, the plans and specifications being under the direct charge of Mr. George W. Armitage.

The capacity of the building will be 250 pupils.

WORK ESTIMATED UPON, BUT NOT UNDERTAKEN, IN CITY OF HABANA.

On January 25 the Hospital de San Lazaro, on San Lazaro street, opposite Reina Battery, was reported to contain 96 lepers, 23 of whom were female and 75 male, 7 Sisters of Charity, and 6 female and 20 male employees, and that it had a maximum capacity of 300 people. The place was generally clean, with the exception of the back yard, but, of course, sanitary conditions were in the same deplorable condition that prevails in the unrenovated public institutions throughout the city.

The ventilation, although the building is located favorably on the seashore, to receive the benefit of the north wind, is wretched. This may be remedied by the conversion of the upper part of the doors and windows into transoms. Concrete floors in the women's apartments and adjacent galleries, tile floors of kitchen and in men's apartments are in bad condition. An estimate for the improvement of the sanitary condition of this building was submitted, to embrace a thorough disinfection and cleaning; whitewashing and painting; ventilating; concrete floors; modern system of sanitary plumbing; a sewer system of vitrified pipe, to replace old masonry box sewers; steam laundry, properly designed, including a sterilizer, and an up-to-date steam kitchen.

ESTIMATE.

| | |
|--------------------------------------------------------------------------------------------------------------------|--------|
| Disinfecting and cleaning | \$500 |
| Whitewashing and scraping, \$2,500; painting, \$1,500 | 4,000 |
| Ventilation | 600 |
| Floors, new concrete, and repairs | 4,800 |
| Plumbing, 24 bath tubs, showers, 26 water-closets, 45 wash basins, 9 slop sinks, urinals | 6,000 |
| Partitions in toilet rooms, etc | 1,600 |
| Sewers | 1,250 |
| Water tanks and pipes | 1,400 |
| Pulling down old buildings, leveling grounds | 300 |
| New buildings, expanded metal plastering, tile, roof, etc., toilet, 2 buildings, 40 by 15 by 12, at \$500 | 1,000 |
| Laundry, 1 building, 90 by 18 by 16 | 1,500 |
| 1 gallery on second floor and roof for toilet, 22 by 15 by 10 | 250 |
| Steam laundry | 4,000 |
| Steam kitchen | 3,000 |
| | 30,200 |
| Ten per cent for incidentals, superintendence, and unforeseen contingencies | 3,020 |
| Total | 33,220 |

QUINTA DE LOS MOLINOS.

On May 14 an estimate of cost was prepared to place in repair and to improve the sanitary condition of the Quinta de los Molinos, known as "summer palace." Subsidiary buildings were found in fair repair, but the palace proper is in a very dilapidated condition.

No sewers being near by, septic tank and filter bed were suggested. Sewage from all buildings was to flow through 6-inch vitrified pipe to a point south of railroad, where disposal works were to be constructed, half in embankment and half in excavation, with effluent pipe leading to masonry flume, running inside of fence along calle de Carlos III.

ESTIMATE.

| | |
|------------------------------------------------------------------------------|-----------|
| Palace: | |
| Tile floors, relaying, 555 square yards, at \$1 | \$555.00 |
| New tile in floors relaid | 462.00 |
| 2 floors, first floor wholly new, 44 square yards, marble tile, at \$7 | 308.00 |
| 240 square yards concrete floor, at \$2 | 480.00 |
| 1,350 square yards plastering, at \$0.50 | 675.00 |
| 828 lineal feet gutters and down spouts, at \$0.30 | 248.40 |
| Repairs to roofs | 175.00 |
| 4,700 square yards scraping and kalsomining, at \$0.10 | 470.00 |
| 4,100 square yards painting, at \$0.30 | 1,230.00 |
| Plumbing | 800.00 |
| Electric and gas lighting | 1,840.00 |
| Carpenter work, hardware, and glazing | 2,640.00 |
| Cartage, disinfection, etc | 275.00 |
| Ten per cent for incidentals and superintendence | 1,015.84 |
| Total | 11,174.24 |

Servants' quarters, stables, keeper's house, and barracks:

| | |
|-------------------------------------------------------|----------|
| Repairs to floors | 120.00 |
| 200 square yards concrete floor, at \$2 | 400.00 |
| 600 square yards plastering, at \$0.50 | 300.00 |
| 1,050 feet gutters and down spouts, at \$0.30 | 315.00 |
| Repairs to roofs | 235.00 |
| 910 squares scraping and kalsomining, at \$1.10 | 1,010.00 |
| 1,500 square yards painting, at \$0.30 | 450.00 |
| Carpenter work, etc | 550.00 |

Servants' quarters, stables, keeper's house, and barracks—Continued.

| | |
|-------------------------------------------------------|------------|
| Cartage and disinfection..... | \$275. 00 |
| Electric and gas lighting..... | 500. 00 |
| Plumbing..... | 1, 450. 00 |
| Ten per cent for incidentals and superintendence..... | 560. 50 |
| | <hr/> |
| | 6, 165. 50 |
| | <hr/> |

Sewers and sewage disposal:

| | |
|----------------------------------------------------------------------|------------|
| 1, 500 linear feet 6-inch sewer pipe, at \$1..... | 1, 500. 00 |
| Septic tank and filter beds..... | 1, 800. 00 |
| 20 per cent for incidentals, contingencies, and superintendence..... | 660. 00 |
| | <hr/> |
| | 3, 960. 00 |
| | <hr/> |

| | |
|------------------|-------------|
| Grand total..... | 21, 299. 74 |
|------------------|-------------|

BOTANICAL GARDENS.

On June 25 it was recommended that the ditch running south through eastern part of the botanical gardens be cleared of rank growth of vegetation and débris which diverted course of stream, and that the work be performed by Vivac prisoners.

ARSENAL.

On May 4 the two principal residence buildings in the arsenal grounds were inspected. The "Casa del Comandante Segundo," recently occupied by the captain of the port, was in excellent condition, some outer storerooms only requiring renovation, but in the "Casa del Comandante Primero," though the building is in good general repair, the sanitary appointments are bad, electric or gas lighting is required, woodwork should be cleaned and painted, and some repairs to roof and gutters are necessary.

ESTIMATE.

| | |
|------------------------------------------------|--------|
| Casa del Comandante Segundo | \$500 |
| Casa del Comandante Primero: | |
| 20 squares tile floor, at \$15 | 300 |
| Plastering | 100 |
| Plumbing..... | 1, 125 |
| Sewers | 750 |
| Electric lighting..... | 750 |
| Scraping walls, painting, and calcimining..... | 846 |
| Carpenter work and hardware..... | 255 |
| Cleaning and disinfection | 400 |
| Roofs and gutters..... | 100 |
| Ten per cent for incidentals | 463 |
| | <hr/> |
| Total | 5, 589 |

HABANA UNIVERSITY BUILDING.

On June 14 an inspection of the Habana University Building on O'Reilly street showed that the estimate of the assistant state architect, Señor Martínez, for \$19,455 was ample, but not extravagant, for cleaning and disinfection, repairs to roof, renewing entirely the second and third floors of the gallery surrounding the east patio, and constructing three rooms on top of these galleries for drafting room, etc., for plumbing, sewers, water supply, gutters and down spouts, and a great deal of incidental work.

On account of the condition of this building it was recommended that no desultory work be done, and that improvements be postponed until funds become available for systematic improvements to harmonize with the use to which the edifice is put; except that sanitary work be done at once, and in such a manner that it would not be wasted should the building be rearranged and remodeled hereafter.

Estimate for sanitation, made by assistant state architect, and verified, is as follows:

| | |
|--------------------------------------------------------|-----------------|
| Cleaning and disinfection | \$400.00 |
| Repairs to roof | 750.00 |
| Plumbing | 3,856.60 |
| Water supply | 1,062.00 |
| Sewers | 386.00 |
| Ten per cent for incidentals and superintendence | 645.46 |
| Total | 7,100.06 |

BACTERIOLOGICAL LABORATORY.

On May 24, a report was made upon the request of the rector of the university that provision be made for a bacteriological laboratory and other improvements at the medical college, corner Belascoain and Zanja streets.

As work had lately been done on this building, according to projects of the medical authorities, it was suggested that the desired improvements to fit the building for a medical college be determined upon comprehensively before any further work was done, otherwise the work of to-day might be rendered useless by the requirements of to-morrow.

ESTIMATE.

| | |
|--------------------------------------------------------|------------|
| Bacteriological laboratory: | |
| 125 square yards concrete, at \$2 | \$250 |
| Expanded metal partition | 150 |
| Sink and fittings | 75 |
| Incidentals | 48 |
| Dog receptacle, 27 square yards concrete, at \$2 | 54 |
| Room, corner Zanja and Belascoain streets: | |
| 100 square yards concrete, at \$2 | 200 |
| 120 square feet windows, at \$0.40 | 48 |
| Room on Belascoain street: | |
| 60 square yards concrete, at \$2 | 120 |
| Incidentals | 37 |
| Total | 982 |

CUSTOM-HOUSE PASSENGER LANDING.

The customs service prepared plans for a passenger landing at the Machina wharf, and built a pile foundation for same. The request for funds was referred to the chief engineer, the plans being subsequently submitted for revision of style of construction, the general arrangement being adhered to as meeting the approval of the collector of customs.

The proposed plan is for a substantial but a very plain building. The building will be erected upon foundation already prepared, and the location of pile piers as driven will determine the location of columns, thereby limiting scope of economical arrangement of iron-

work, and the existing length of spans preclude the possibility of the rational use of timber beams.

Iron-work: The facility of obtaining promptly cast-iron columns here in Habana, and I beams being stock articles quickly obtained from the States, coupled with the comparative cheapness of erection, are the reasons for adopting same. The roof will be of metal with an air space between inside of roof and ceiling sheathing. The floors are of dressed yellow-pine beams, and tongue and grooved flooring. The sides and partition of building will be wood studding and expanded metal plaster; the ornamentation will be unpretentious, but is unavoidably expensive, nevertheless. The windows will be white pine and glass, with white-pine Louvre blinds, where necessary, of local prevailing patterns. Doors will be plain and of white pine. Plumbing will be sanitary but plain; toilet-room partitions to be of iron. Counters and benches will be plain, and of selected yellow pine. Electric lighting will be installed with fixtures of same class used in the old post-office building.

Painting: All inner woodwork will be finished in oil, to preserve natural colors. All plaster work will receive two coats of alabastrine, of approved tints. Exterior woodwork will be painted in oil color.

Fender will be added on bay side of wharf, and steps to edge of water on south side.

PROPOSED GIRLS' REFORMATORY ON REINA STREET.

In conjunction with Major Greble, assistant adjutant-general, division of Cuba, sketch plans were prepared for utilization of the storehouse and three abandoned foundations on Reina street, opposite the Quinta de los Molinos, as a reformatory for girls. It was intended to use present building for administration purposes, director's living quarters, schoolrooms, workrooms, etc., and to construct new two-story building on old foundation, employing the "cottage" system, whereby each building was divided in half, each containing a distinct "cottage." Each cottage was to be occupied by about 40 inmates; upstairs embraced the dormitory, toilet rooms, properly isolated and sanitarily arranged, and matron's apartments. Upon the lower floor was the kitchen, pantry, storeroom, dining room, sewing room, and reception room. Porches were to surround the structures. This work was not authorized, pending the consideration of the Aldecoa Farm for such purposes. There being no sewer at this point, disposal of sewage was contemplated by septic tank and filter bed.

ACADEMY OF SCIENCES.

An inspection of the Academy of Sciences was the result of a request for funds for the remodeling of that building, but the dispute in title (the property being claimed by the Catholic Church) has prevented any action toward its renovation.

WORK UNDERTAKEN IN HABANA.

MERCEDES HOSPITAL.

On June 19 a report was made upon the pressing needs of the Mercedes hospital, as outlined by Major Greble, superintendent of charities.

Subsequent to the above, the medical authorities desired that the operating room be artificially ventilated to avoid the excessive heat during an operation, and the governor-general directed that an estimate of cost be made.

The conditions demand that the air be filtered to prevent introduction of dust, that the velocity be not over 2 feet per second to avoid drafts, that speed of fan be low to reduce noise to a minimum, that the action be positive and responsive to demands, and that sufficient air for thirty people be supplied.

To fulfill these conditions it is proposed to install, in an adjoining room, a fan operated by an electric motor, obtaining power from a storage battery of capacity sufficient for a four-hour run. The air will be drawn through an opening in a shaded angle of the building, and filtered through a screen of cheese cloth. After leaving the fan it will pass through a simple cooling apparatus, and discharge into the operating room through openings $13\frac{1}{2}$ feet above the floor, passing out of the room through openings along the washboard. The estimated cost of this installation is \$1,762.

In this connection a report of general conditions of the building was submitted, as follows:

The building is located on the east edge of the Vedado, west of Santa Clara battery, and north of the Pirotecnia. It is of the usual stone construction of this locality, its plan seems admirable, and, with the remedy of some sanitary constructional defects, the institution will be excellently fitted for its purpose.

The plan of the institution embraces a central administration building, two stories in height, which is connected with kitchen by a long central passageway. Beyond this kitchen, across an arcaaway, is a one-story range of buildings, used for storage, machinery, and isolation ward. At right angles to administration building, where it joins passageway to kitchen, a corridor extends both ways, off each side of which wards (about 100 by 20 feet) extend in such manner that the wards on one side alternate with the wards on the other, thereby surrounding each ward with a patio, securing ample light and ventilation.

The institution will accommodate 225 patients without crowding, and has at present 32 trained nurses and female employees, and 76 male employees. The institution is kept clean and neat.

Plumbing: The plumbing is located at the end of each ward and in various toilet rooms throughout the building. The plumbing fixtures are very unsanitarily installed, there being no vents or revents, the connections to sewers being improperly made, and the traps not being set to a true level. Syphonic action is everywhere noticeable. Where bell traps occur the bells are removed, permitting sewer gas to escape at all times. As each toilet room is provided with a bell trap, this is a serious matter. Most of the fixtures can be utilized after being properly reset.

Sewers: These are of stone, rectangular in shape, and unfit for the use to which they are put; which is, to carry sewage, roof and drainage water, gas escaping freely below the windows. The sewers empty first into a vault, thence overflowing to the sewer connecting hospital No. 1 with the bay, via Santa Clara battery. This sewer is insufficient to carry roof water during heavy rains. The vault is located under laundry, and its gases readily permeate through the floor. The leaders from roof are not trapped, and are therefore conduits for sewer gas.

Waste pipe from kitchen sinks and servants' dining room, pot sink

room, and patients' dish-washing room are untrapped and enter a badly constructed and dilapidated box drain. As kitchen waste is the same as sewage, except as to state of putrefaction, this is in itself a menace to health.

The steam laundry is of a French make and of an antiquated type. The mangle is small, and has but one roll and one steam drum. The centrifugal extractor is large and hard to operate. The two washing machines are of wood and look badly. No dry room exists.

The kitchen, while small and containing but one range, seems to give satisfaction.

RECOMMENDATION.

Plumbing should be sanitarily installed, using present fixtures where found suitable.

Sewers: A separate system of sewage should be employed; one system for sewage, the other for roof and surface drainage.

A steam laundry of adequate size and modern design should be erected.

A steam cooking apparatus of proper design and capacity should be installed.

An electric-light plant of most economic and best type, large enough for future increase, should be constructed.

Operating room and concrete floors, as contemplated in estimate of civil file No. 1303, division of Cuba, should be provided for, and concrete floors constructed wherever necessary.

While some of these improvements may not be imperative, the money could not be better expended to the advantage of the community than at this hospital, the excellent plan of which should carry with it all up-to-date appurtenances.

Serious consideration should at any rate be given to the sanitary improvements as herein outlined.

Estimate of cost of improvements necessary to place Mercedes Hospital in first-class condition

| | |
|-----------------------------------------------------------------------------------------------------------------------------------|----------|
| Operating room | \$1, 614 |
| 3,000 square yards concrete floors, at \$2 | 6, 000 |
| <hr/> | |
| Electric-light plant: | |
| Labor, wiring 400 lights | 1, 000 |
| 1 25-kilowatt dynamo | 1, 000 |
| 1 40-horsepower engine | 1, 200 |
| 1 80-horsepower water-tube boiler | 2, 000 |
| 1 boiler feed pump | 100 |
| 1 100-horsepower feed-water heater | 250 |
| Switch board and station instruments | 300 |
| Installation | 300 |
| 20 per cent for incidentals and contractor's profit | 1, 230 |
| <hr/> | |
| | 7, 380 |
| <hr/> | |
| Plumbing: | |
| 10 toilet rooms for wards, each having 1 slop sink, 1 bath tub and shower, 1 water-closet, 1 basin, and 1 urinal, at \$2.20 | 2, 200 |
| Toilet rooms for director's office, female servants, male servants, male employees, 6 in all, at \$330 | 1, 980 |
| 20 per cent for incidentals and contractor's profit | 836 |
| <hr/> | |
| | 5, 016 |
| <hr/> | |

| | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Sewers, 1,300 linear feet of 4-inch and 400 linear feet of 6-inch vitrified pipe, with all appurtenances, at \$1 | 1,700 |
| Drains, 1,340 linear feet of 5-inch, 1,340 linear feet of 6-inch, and 400 linear feet of 12-inch vitrified pipe, with all appurtenances, at \$1 | 3,080 |

Steam laundry:

| | |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| To comprise an electric motor (left over from Hospital Militar), 1 washer, 1 sterilizer, 1 extractor, 1 mangle, 1 starch kettle, 1 soup kettle, 1 ironer, and dry room | 3,500 |
| Contractor's profit | 700 |
| | <u>4,200</u> |

Steam kitchen:

| | |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| To contain 2 steam-jacketed kettles, 3 vegetable steamers, 2 tea and coffee urns, 1 four-hole range, 1 hot-water heater, 1 dish-washing machine, 1 coffee roaster, 1 coffee grinder, 1 meat chopper, 1 dough kneader, 1 bake oven, sinks, sauce-pan racks, tables, etc | 3,400 |
| Incidentals and contractor's profit | 680 |
| | <u>4,080</u> |

| | |
|-------------|--------|
| Total | 33,070 |
|-------------|--------|

On June 26, 1900, the division commander authorized the expenditure of \$24,790 to cover expenses of improvements included in general recommendations, except for laundry and kitchen. Plans and specifications for the work are being prepared.

On June 27 the division commander authorized the construction of the operating room by Government forces instead of by contract, its prompt preparation being imperative.

CUARTEL DE LA FUERZA ARCHIVES.

On March 15 estimate of costs of minor repairs was made upon the Cuartel de la Fuerza, principally upon windows and doors, and for providing wooden cases for storing archives, to which purpose this building has latterly been devoted. This estimate, as forwarded to the division commander, was as follows:

| | |
|---------------------------------------------------------------------------------|-----------------|
| Minor repairs to building, renewing window netting and repairing shutters | \$187.50 |
| Repairs and glazing skylights | 24.00 |
| Repairing doors | 32.00 |
| Painting | 10.00 |
| Repairs to roof | 50.00 |
| 45 windows to be equipped with pivoted lights | 450.00 |
| Old cases: | |
| Taking down and removing cases from hacienda to La Fuerza | 92.50 |
| Repairing old shelving | 172.50 |
| Moving records | 72.50 |
| New shelving, etc., yellow pine, 1,226 linear feet, at \$3.20 | 3,825.12 |
| Fire protection, 10 Rex extinguishers (one to each room), at \$15 | 150.00 |
| Total | <u>5,066.12</u> |

| | |
|-------------------------------------------------------------------|----------|
| If white pine is used, add | 1,542.15 |
| If cedar is used, add | 1,987.65 |
| Ten per cent for incidentals was asked for, allotment being | 5,573.12 |

East room on harbor over gun room being abandoned for record-storage purposes, work done did not reach amount estimated, as shown on general financial statement.

The wooden file cases are the most expedient under existing financial conditions, but when funds are available this ancient landmark

can be transformed into a depository for archives, with all modern appointments, without destroying its value as an interesting relic. The roof should be entirely of steel and glass. Floors may be easily tiled or concreted.

Shelving, cases, etc., should be of metal, such as is employed in the construction of the Congressional Library at Washington.

RECOGIDAS.

After a visit to the Recogidas, the prison for women on O'Farrel street, near Compostela Street Orphan Asylum, made famous by the escape of Senorita Cisneros during the late war, the division commander authorized an expenditure of \$5,000 for its renovation. Work was commenced March 1, was ready for occupancy March 10, and completed March 15. The premises were thoroughly cleaned, disinfected, whitewashed, and painting was done on all the woodwork. A sewer connection was made from box sewer with cast-iron soil line, which was extended through the center of the patio, connecting with branches to officers' toilet room, to large room upstairs, and branches to closets, showers, basins, large masonry wash basin, kitchen sink and hot-water boiler, all located in patio.

Sewer terminated in vent pipe at east end of patio and was extended to above roof.

Plumbing was first class and sanitary, properly trapped, vented, and back-aired. Large room upstairs was provided with 2 closets and galvanized sink. Four closets are located in small octagonal building in patio, and 4 showers, provided with hot and cold water, are located in another similar building. New kitchen was provided with range, galvanized sink and hot-water boiler. Officers' toilet room contained 1 shower, 1 water-closet, 1 basin, and 1 slop sink. All closets were porcelain bowl, hard-wood seat, hard-wood copper-lined cistern, with N. P. flush and water pipe. Slop sinks and basins were enameled iron. Two rows of iron, enameled detachable basins, upon iron supports, were placed in patio. Woodwork was thoroughly repaired. Tile floor was laid in rooms upstairs. All floors downstairs were paved with concrete. Stone slabs of almost the entire patio were relaid. Roof was repaired. Skylights and ventilators were placed over 2 rooms. Shelving and tables were constructed. Iron grating was placed on one window. Copper kettle over furnace was placed in patio for boiling clothes.

Amount of allotment exceeded largely the cost of renovation. Major Greble equipped the prison, charging bills to this fund. See financial sheet for detailed expenditures.

BELASCOAIN BARRACKS.

On March 27 report of condition of Belascoain Barracks, corner Zanja and Belascoain streets, was made. This building was placed in a thoroughly sanitary condition in May, 1899, changing plumbing work previously performed by sanitary department. Notwithstanding the fact that this building is occupied by a medical school, the toilet rooms were again found in a very dilapidated condition. Closets were torn out, seats wrenched from their fastenings; leaks in water pipes; woodwork around corridors in bad condition; roof leaky, and floor downstairs in north corridor, composed of patch work of boulders, cement,

and wood, should be renewed with concrete. The estimate, as approved by division commander, is as follows:

| | |
|-------------------------------------------------------------------------------|----------|
| 1. Repairs to woodwork, corridor, west side, 900 square feet, new, at \$0.50. | \$450.00 |
| 2. Repairs | 78.00 |
| 3. North side, entirely new, 1,000 square feet, at \$0.50 | 500.00 |
| 4. Glass for north and west sides, 650 square feet, at \$0.50 | 325.00 |
| 5. 600 square feet expanded metal partitions, at \$0.30 | 180.00 |
| 6. Cement floors, 1,800 square feet, at \$0.20 | 360.00 |
| 7. Roof repairs | 100.00 |
| 8. Painting, 100 squares, at \$3 | 300.00 |
| 9. Plumbing, repairs to 6 closets and 6 closet tanks | 6.00 |
| 10. Repairs to 6 oak seats and furnishing 1 closet bowl | 30.00 |
| 11. New tanks in place | 70.00 |
| 12. Tile floors | 25.00 |
| 10 per cent for incidentals | 242.40 |
| Total | 2,666.40 |

At the request of the medical director, and by direction of the division commander, the chief engineer directed certain changes, the work actually done being as follows:

Wooden lattice blinds with glass transoms inclosed the upstairs corridors and those on the first floor on west side. Items 1, 2, 3, and 4 of above estimate covered cost of placing all blinds in good condition, but blinds on first floor were removed and not replaced. Blinds upstairs were entirely repaired, new blinds being placed where necessary.

Expanded metal plaster partitions were erected upstairs to create additional class rooms. Water-closet partitions were constructed of same material. Concrete floors were placed in north and east corridors. Tile floors were repaired where necessary, and in the upper north corridor where old stairs were removed.

In large west room five new windows of ground glass were placed.

Originally the plumbing was installed to suit the requirements of two companies of infantry, but to adapt it to the uses of a medical college 4 closets were torn out of one toilet room and 3 urinals placed in their stead. In the other toilet room closets were repaired. Partitions and doors were erected at all closets. Basins were thoroughly repaired. Waste from sink on upper floor, east side, was carried to sewer line. Officers' toilet room, at intersection of upper east and north corridors, was removed to afford continuous passageway, and for the same reason stairs at this point from the lower corner room were demolished.

Three brick partitions were removed in west part of wing on Zanja street to obtain one large class room, and large door in corner room on Belascoain street was partly bricked up and converted into a window. One medicine case was built. Glazing was done when necessary, as were also other minor repairs. Leaks in roof were repaired.

Financial sheet shows expenditures in detail.

HACIENDA BUILDING.

This large building is the seat of the general civil government of the island, and is located west of the foot of Obispo street. In connection with Mr. Martinez, assistant state architect, plans and estimates were prepared for the sanitary improvement of this building, and were forwarded by the chief engineer to the division commander on March 3, being subsequently approved, the work to be prosecuted under the

direction of Mr. J. R. Villalon, secretary of public works, which order is being executed.

ESTIMATE.—WORK URGENTLY REQUIRED.

| | |
|---------------------------------------------------------------------------------------|----------|
| 1. Cleaning and disinfection of building and sewers..... | \$2, 000 |
| 2. Cartage..... | 500 |
| 3. Grading and removing débris..... | 500 |
| 4. Concrete floors..... | 6, 000 |
| 5. Plastering..... | 2, 800 |
| 6. Carpenter work, tearing out wooden partitions, repairs to doors, windows, etc..... | 1, 000 |
| 7. Plumbing..... | 8, 250 |
| 8. Sewers..... | 2, 700 |
| 9. Water supply..... | 2, 600 |
| 10. Iron work..... | 400 |
| 11. Roof repair..... | 900 |
| 12. Painting and scraping..... | 2, 200 |
| 13. Whitewashing..... | 600 |
| 14. Daily disinfection and cleaning..... | 200 |
| 15. For urgent work, other than ground floors..... | 2, 000 |
| 16. Gallery around entresol..... | 2, 000 |
| 17. Expanded metal house on roof..... | 4, 400 |

Total immediately required 39, 050

The chief engineer recommended to the adjutant-general on March 3 that if this amount be increased to \$40,000 the above work could be done and a plant installed sufficient to run the elevator.

ADDITIONAL AMOUNT REQUIRED TO PLACE BUILDING IN FIRST-CLASS CONDITION THROUGHOUT.

| | |
|-----------------------------------------------------------------------------|--------|
| 18. Cartage..... | \$500 |
| 19. Removing débris..... | 500 |
| 20. Tile and concrete floors..... | 6, 300 |
| 21. Marble floors..... | 8, 000 |
| 22. Plastering..... | 1, 200 |
| 23. Carpenter work, tearing out partitions, repairs to doors and windows... | 1, 500 |
| 24. Iron work..... | 300 |
| 25. Electric wiring, fixtures, etc..... | 8, 550 |
| 26. Painting, scraping, and glazing..... | 2, 800 |
| 27. Whitewashing and scraping..... | 2, 400 |
| 28. Daily cleaning and disinfection..... | 300 |
| 29. Elevator..... | 5, 000 |
| 30. Asphalt block paving in patio..... | 4, 500 |

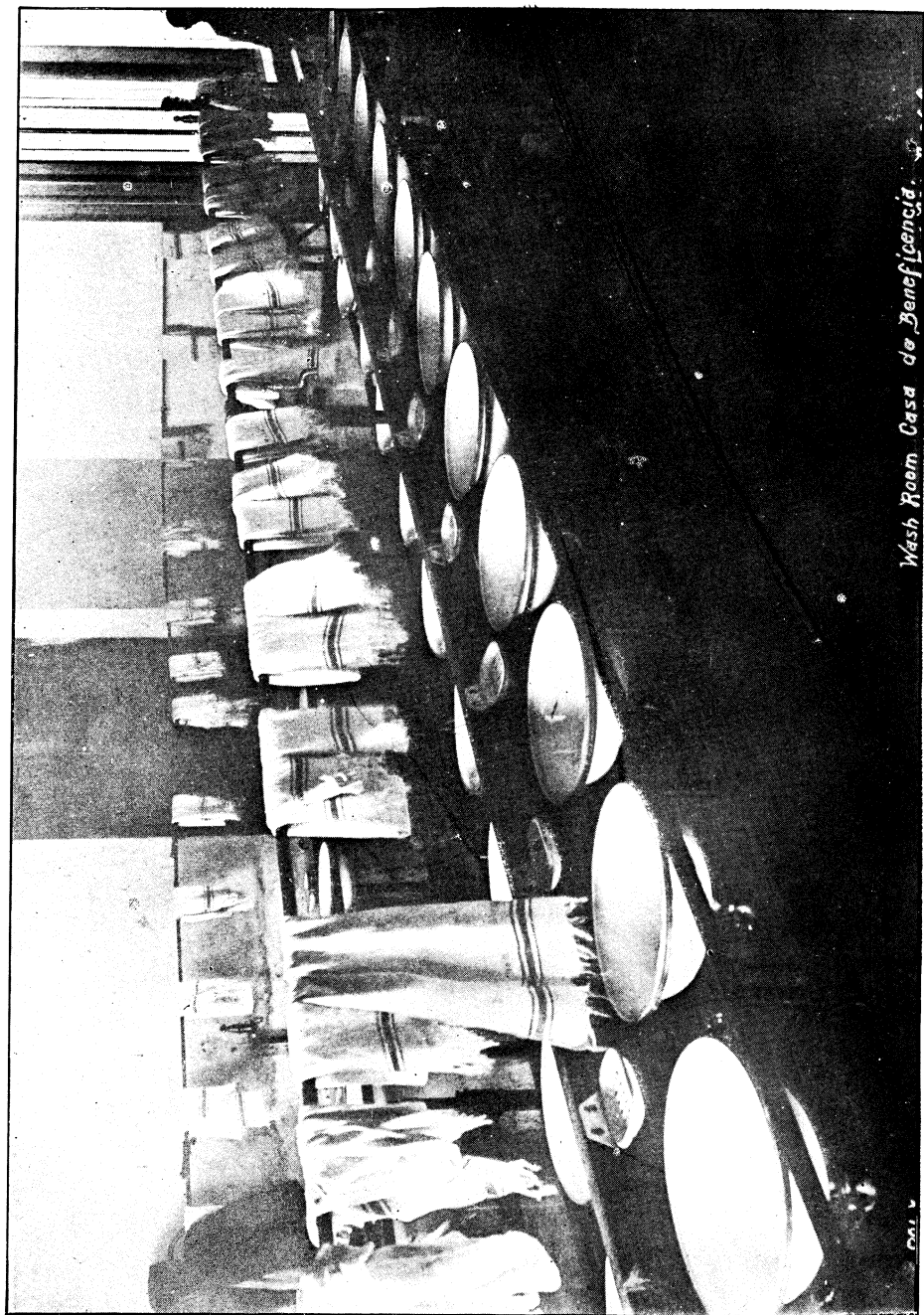
41, 850

Less item No. 16..... 2, 000

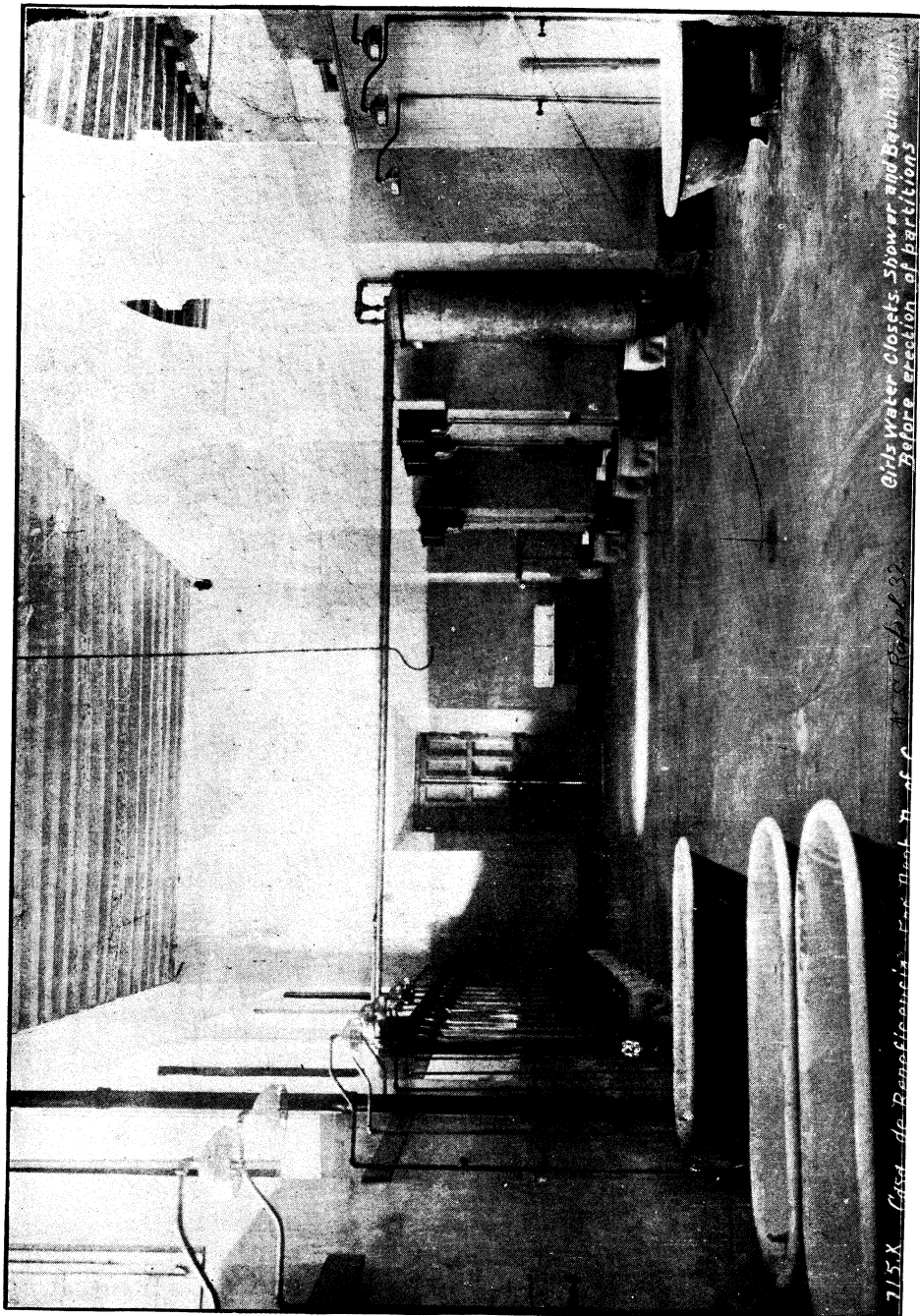
Total..... 39, 850

CASA DE BENEFICENCIA.

On December 30, 1899, the Casa de Beneficencia, corner of San Lazaro and Belascoain streets, was inspected, the institution being an orphan asylum and home for a few aged and infirm. It was found exceptionally clean, but sanitary arrangements, plumbing, and sewage were abominable. Building in good general repair. Kitchen and laundry appointments crude in the extreme. Playground space inadequate. The sewers were of stone, rectangular in section, with a good fall, except from the extreme west wing, and discharged into trunk sewer on Belascoain street. Water-closets were seriously insufficient in number, representing several antiquated types, with no attempt at sanitary plumbing. The few showers were over large pools, which



Wash Room Casa de Beneficência.



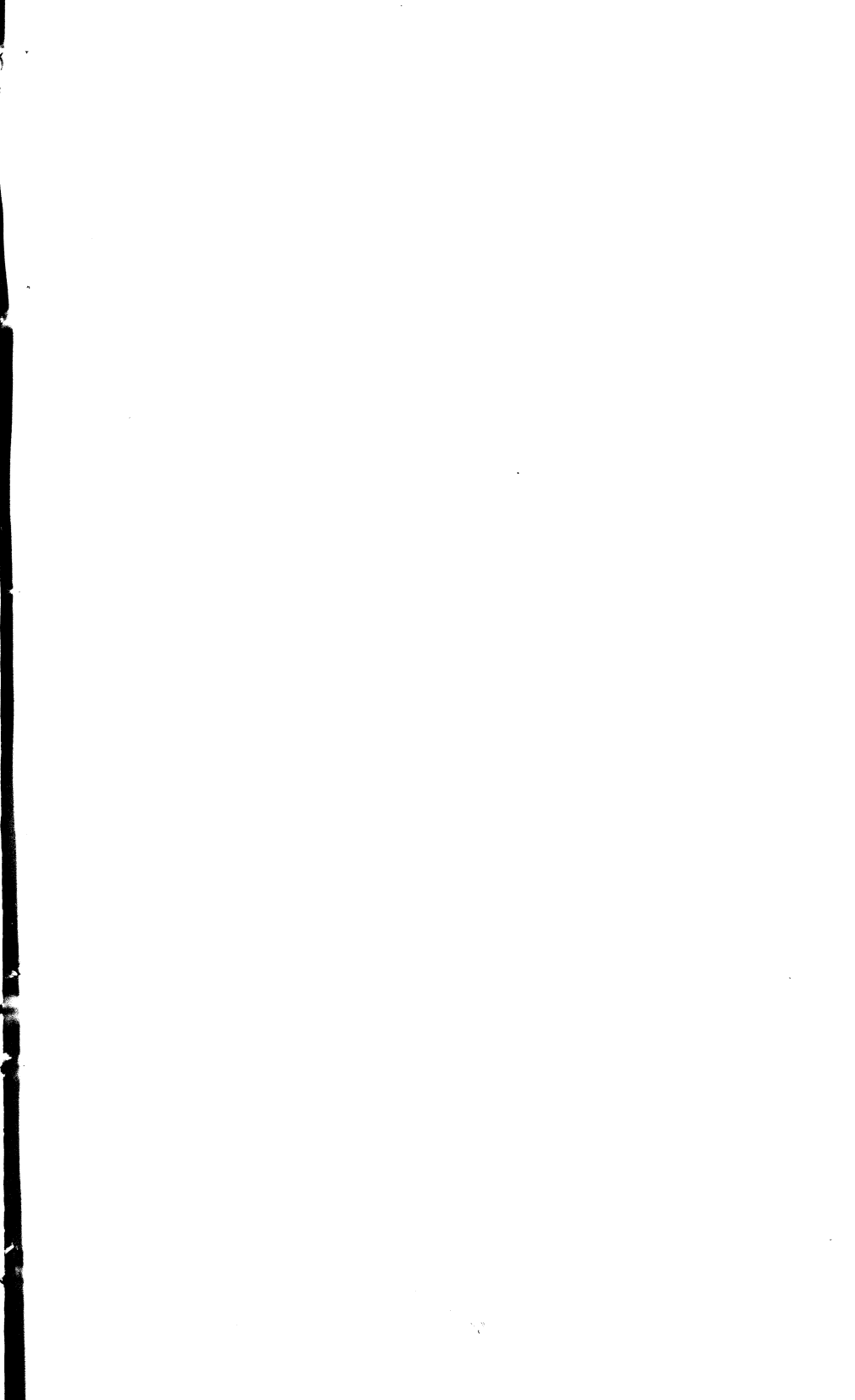
*Girls Water Closets. Shower and Bath Room.
Before erection of partitions.*

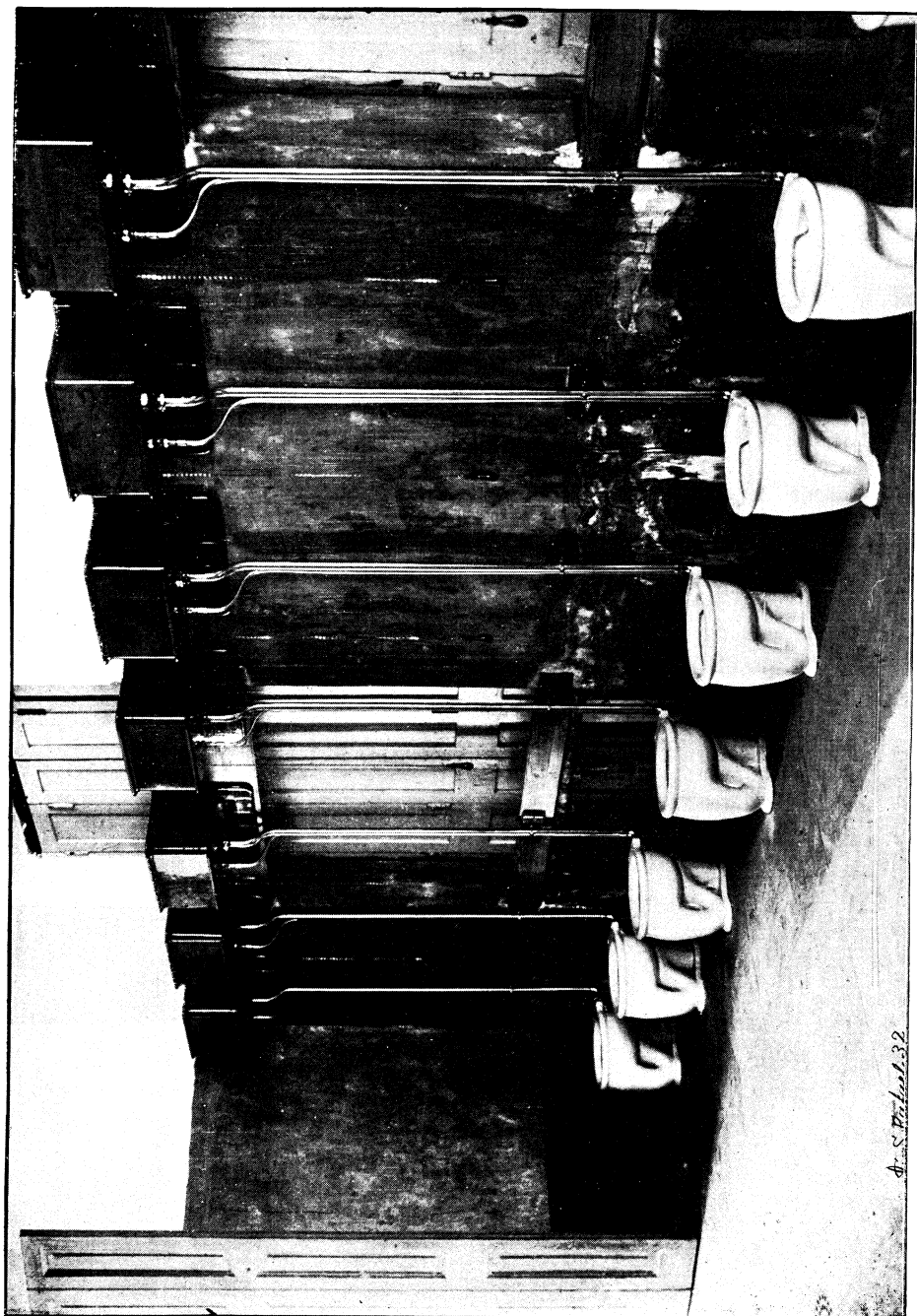
715.X Casa de Beneficencia, P. R. Photo H. C. A. P. 1912

CASA DE BENEFICENCIA—GIRLS' WATER-CLOSETS, SHOWER AND BATHROOM, BEFORE ERECTION OF PARTITIONS.



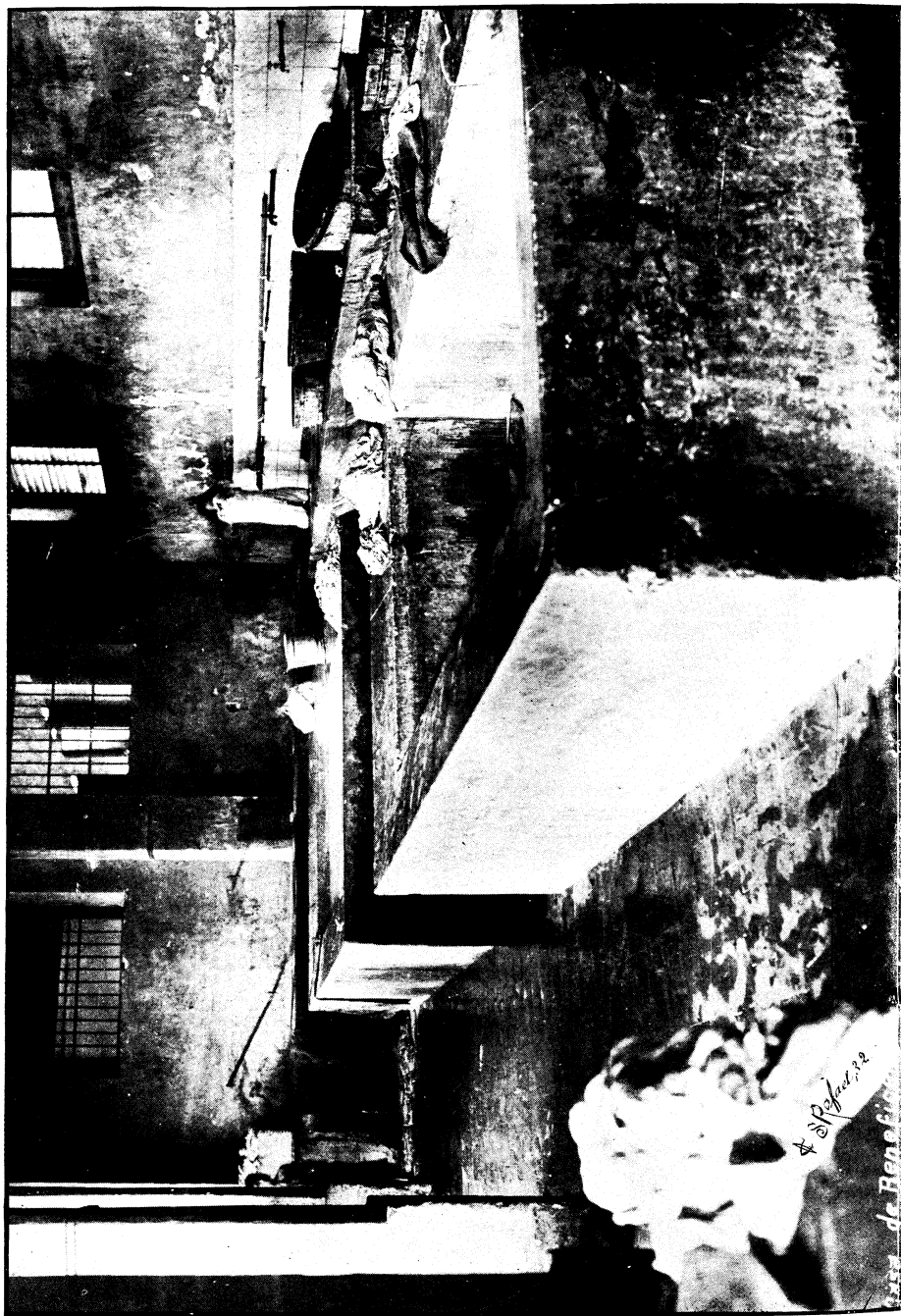
CASA DE BENEFICENCIA—OLD TYPE OF WATER-CLOSETS.





CASA DE BENEFICENCIA—NEW TYPE OF WATER-CLOSETS.

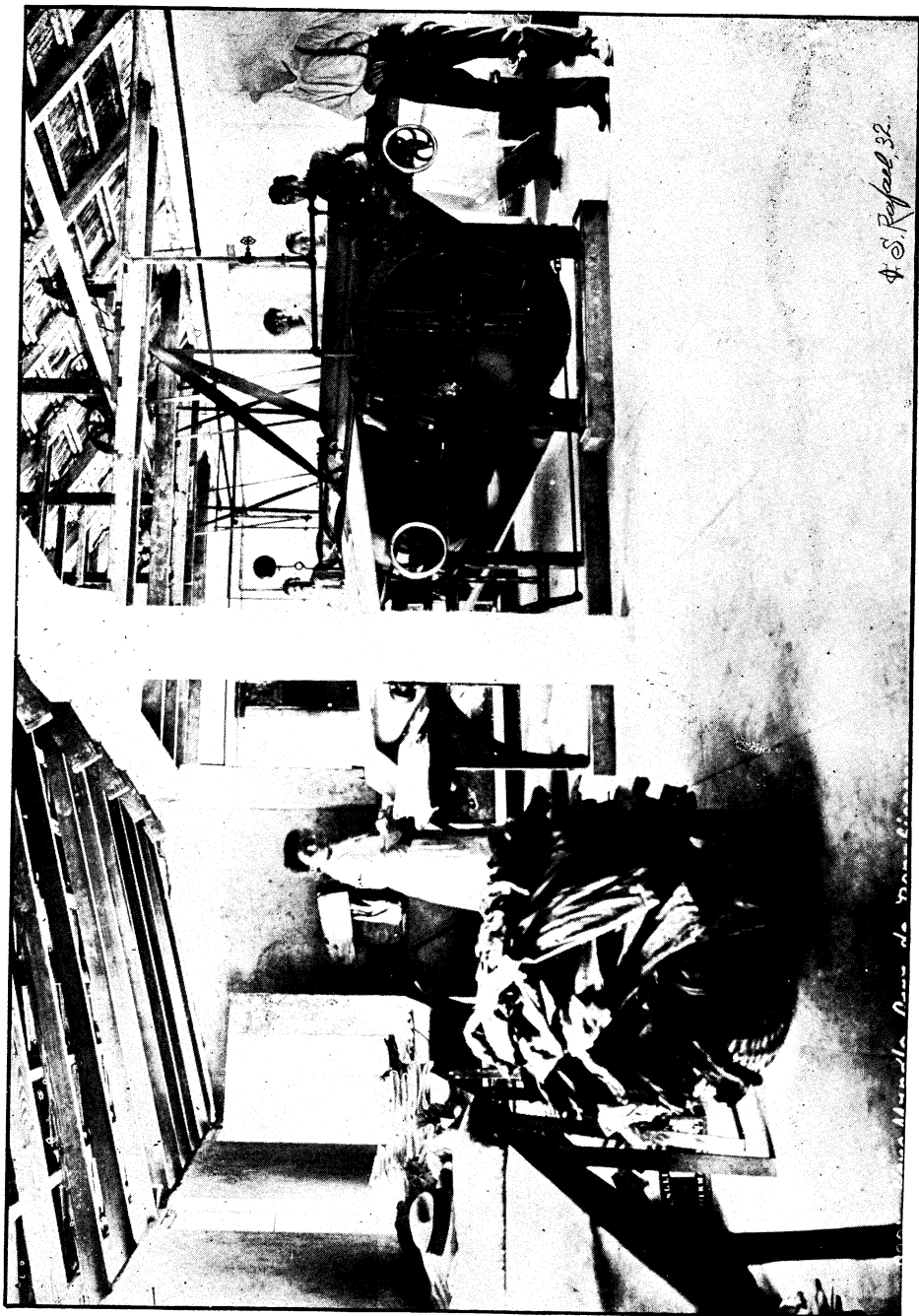
Dr. S. P. H. 32



CASA DE BENEFICENCIA—LAUNDRY, OLD METHOD, MAY 16, 1900.



CASA DE BENEFICENCIA—NEW WASHER.



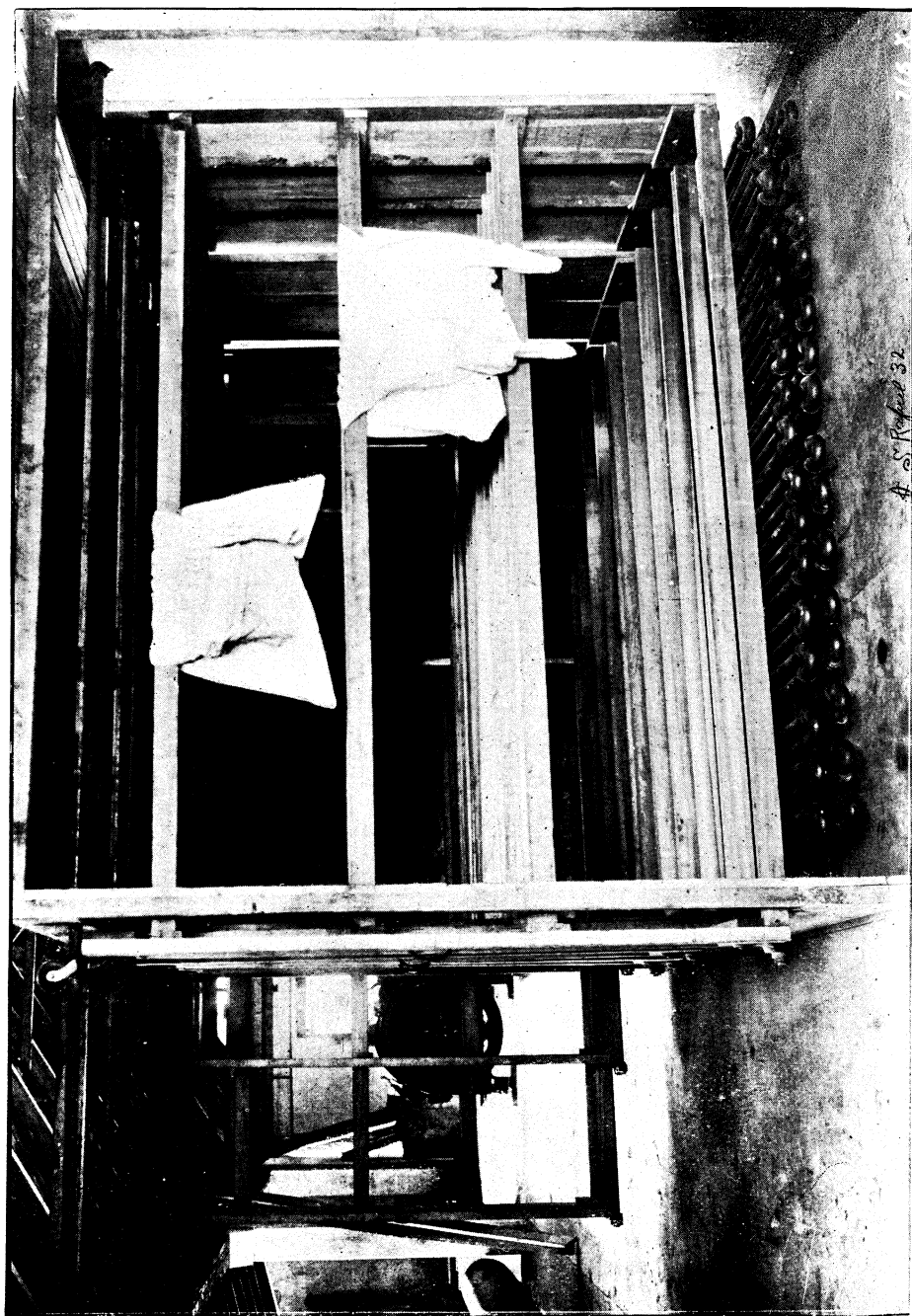
4 S. Rafael 32.

CASA DE BENEFICENCIA—NEW MANGLE. JUNE 27, 1900.



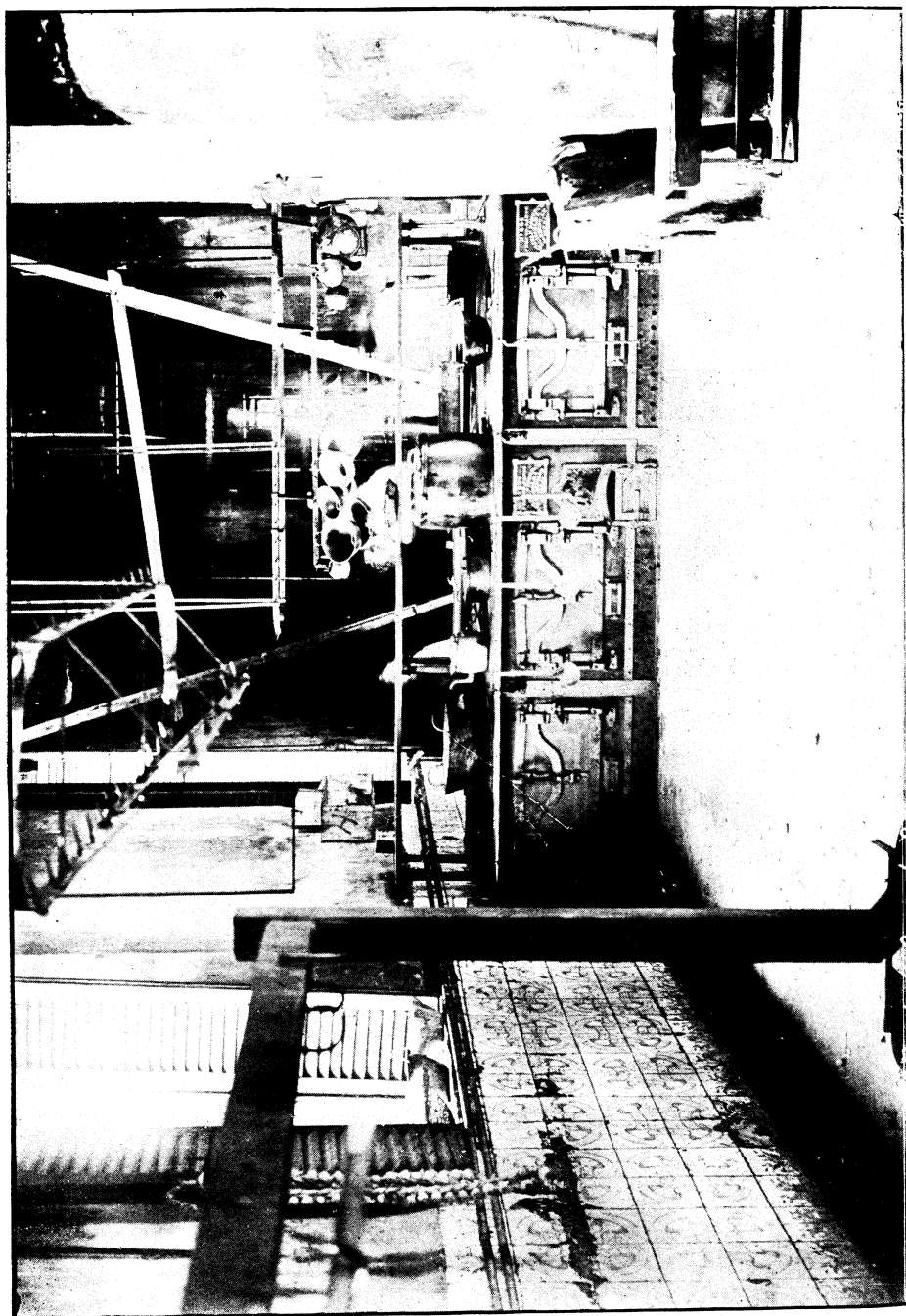
H. S. Rafael, 32.

CASA DE BENEFICENCIA—DRYING CLOTHES, OLD METHOD. MAY 16, 1900.



4 S. K. 32

CASA DE BENEFICENCIA—DRYING CLOTHES, NEW METHOD.



CASA DE BENEFICENCIA—NEW RANGE.

are exceedingly difficult to keep clean. The ventilation of the building was bad, as evidenced by the "stuffy" condition of the atmosphere. There were no floors in covered passageways on San Lazaro street wing nor in new building used as carpenter shop. Floors were bad in and around kitchen. Dining rooms were located in various parts of the institution. The kitchen range was old and broken; boiling pots unusually hard to handle and cleanse. There was no bakery. Washing was done in masonry tubs by hand. Absence of gymnasium was very noticeable. Total capacity of building is about 1,200. The inmates at this time consisted of: Infants, 64; boys, 323; girls, 338; aged and infirm, 41; attendants, 75.

Estimate of cost forwarded on January 29 was for \$32,640, and included concrete floors, constructing transoms in upper part of windows for ventilation, a modern sewer and plumbing system, adequate water supply, steam laundry and steam kitchen. Plans and specifications were prepared and bids advertised for and opened on March 7, 1900. The plans were very thorough in detail, showing the smallest fittings. The lowest bidders were as follows: Plumbing, Adolph E. Mueller & Co., \$11,440.87; sewers, Gomez, O'Brien & Co., \$1,650; water supply, Gomez, O'Brien & Co., \$4,835; concrete floors, Newhall Engineering Company, \$1,440, and transoms, R. Guzman & Co., \$920.

Gomez, O'Brien & Co. being the lowest bidders on plumbing, sewers, and water supply, taken as a whole, it was recommended that they be given that work, and that Purdy & Henderson be given the concrete floors at \$2,160, on the ground that the bid of the Newhall Engineering Company was not sufficient to cover cost of material, without considering the cost of labor. This recommendation was not approved by the chief engineer, who ordered that the contracts be awarded to the lowest bidders for each class of work.

Floors were let to Purdy & Henderson, the error having rendered the latter award necessary. Gomez, O'Brien & Co., claiming that they had bid low on water supply and sewers in order to get the work awarded to them as a whole, refused to accept the award. The contracts let were as follows: Plumbing, Adolph E. Mueller & Co., \$11,440.87; 1,200 square yards concrete floors, at \$1.80, to Purdy & Henderson; 150 transoms to R. Guzman & Co.

All sewers were laid to a grade calculated to produce a velocity of 3 feet per second, and consisted of 576 linear feet of 4-inch, 882 feet of 6-inch, and 212 feet of 8-inch pipe, with clean-outs, manholes, and fresh-air inlets, placed at proper points. The water supply consists of a 3-inch inlet, leading from a tap in street main on Belascoain street to the engine room located in laundry building, in which is located a steam pump, which pumps into 3 tanks on the roof of the building. From these tanks supply lines lead to toilet rooms. The pump has a by-pass attachment and a Fisher regulator valve, by which means benefit of the pressure on street mains is secured when pump is not in use, and the regulator valve permits the movement of the pump only when the level of water in tanks falls below a given height. The plumbing is concentrated as much as possible, and located at convenient points throughout the building, and consists of 75 water-closets, 25 feet of trough urinals, 2 marble basins, 26 iron enameled sectional basins, 296 detachable iron enameled basins on iron supports, 33 iron enameled washtubs, with showers, 8 laundry tubs, 64 separate showers, 2 kitchen sinks, and 19 slop sinks.

Closets are of the wash-out type, porcelain bowl, oak seat, oak copper-lined cistern, nickel water and flush pipe. Urinals are of enameled iron, with automatic flush tanks. Kitchen sinks are of galvanized iron. Laundry tubs are of enameled iron, and will be used with hot or cold water for bathing infants. Slop sinks are of roll-rim enameled iron.

The plumbing is installed according to the latest practice in the United States, properly trapped, vented, and back-aired. The laundry machinery was originally intended to be installed at the Hospital Militar carcel, but when that building was abandoned for carcel purposes, the plant was delivered at the Casa de Beneficencia, and consists of 2 metallic washers, 37 inches in diameter and 64 inches long; 1 26-inch centrifugal extractor; 1 100-inch intermediate mangle; 1 10-inch draw; 10-inch face panel frame dry room; 1 100-gallon galvanized soap tank; 1 15-gallon jacketed starch kettle, together with all necessary shafting, couplings, hangers, pulleys, etc. The contract for the above was filled by the American Laundry Machinery Company for \$4,000.

The steam cooking apparatus was furnished by the John Van Range Company for \$4,300, and consists of the necessary overhead trolleys and food conveyors; 1 6-fire and 6-oven French duplex range; 4 cast-iron 33-gallon vegetable steamers; 3 80-gallon full jacketed kettles for soups and stews; 3 full double jacketed meat roasters; 1 80-gallon copper jacketed kettle for fruit; 2 80-gallon coffee urns; 1 meat chopper; 1 coffee mill; 1 coffee roaster; 1 coal truck; 1 galvanized iron vegetable sink; 2 triple sauce-pan racks, 16 feet long; 1 66-gallon galvanized iron vegetable sink; 1 66-gallon galvanized iron water heater; 2 portable brick ovens; 1 1½-barrel dough kneader, together with all necessary vent pipe and connections; 1 bread-proving box, 1 baker's sink.

Power plant consists of 1 25-horsepower vertical engine; 1 40-horsepower vertical boiler; 1 75-horsepower Cochrane feed water heater; 1 boiler feed pump, and 1 receiver and pump.

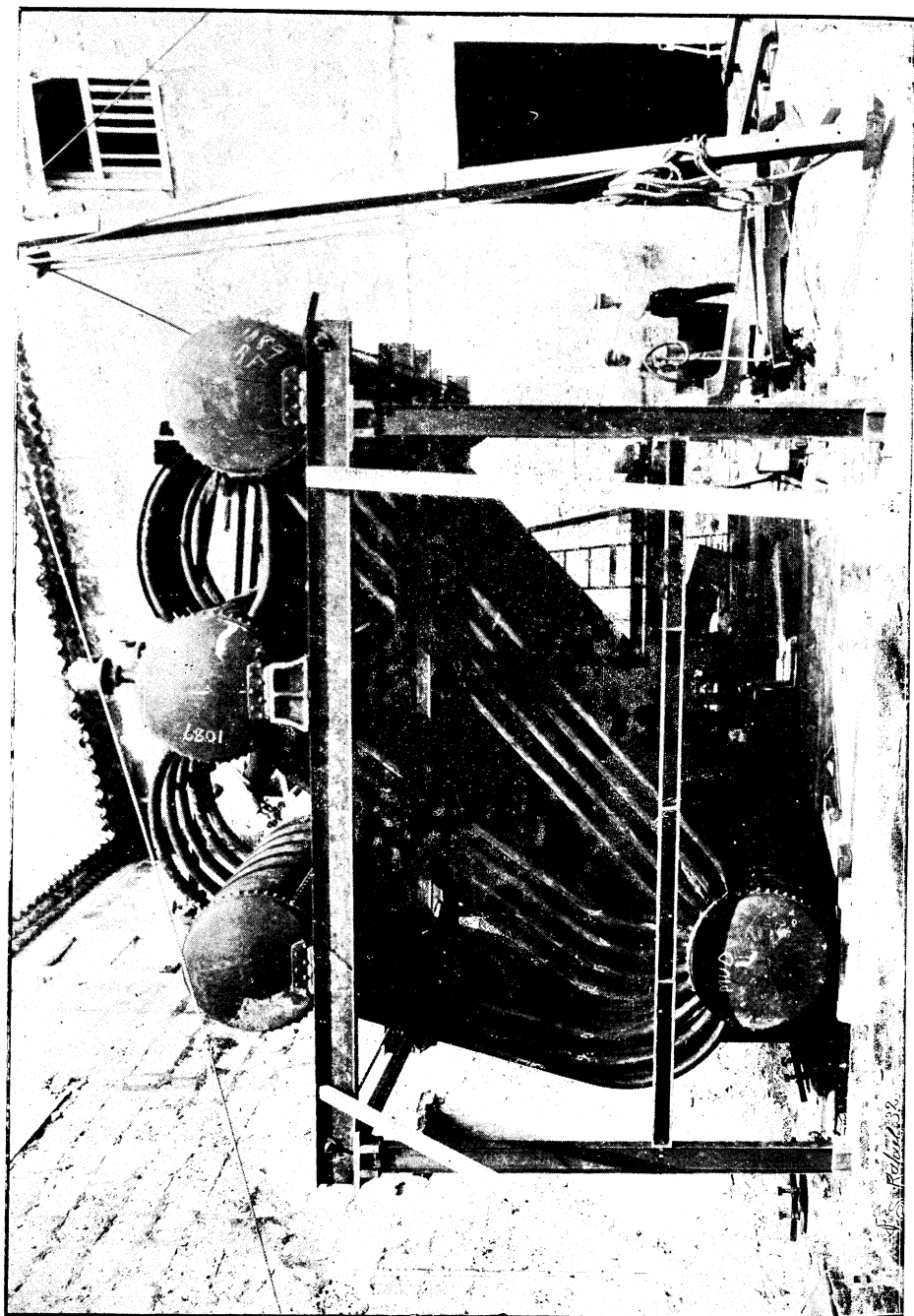
The contracts were carried out with but very little trouble to the engineer, under a very rigid inspection, and in this respect Adolph E. Mueller & Co. deserve especial mention. The water supply and power plant and the sewers were constructed by the government forces at a cost of \$4,586.04. Three tanks were constructed of cypress, instead of iron, at a cost of \$165, the lowest figure received on latter being \$1,050, a saving of \$885, which, added to the above cost of sewers and water supply, makes \$4,471.04, and if constructed on same basis as bids called for, a saving of \$1,003.96 upon bidder's price, who refused the work on the ground that his figure was too low.

These figures accentuate the fact that the engineer department has repeatedly done work at a cost lower than prices obtainable by contract. Final figures of contractors are as follows:

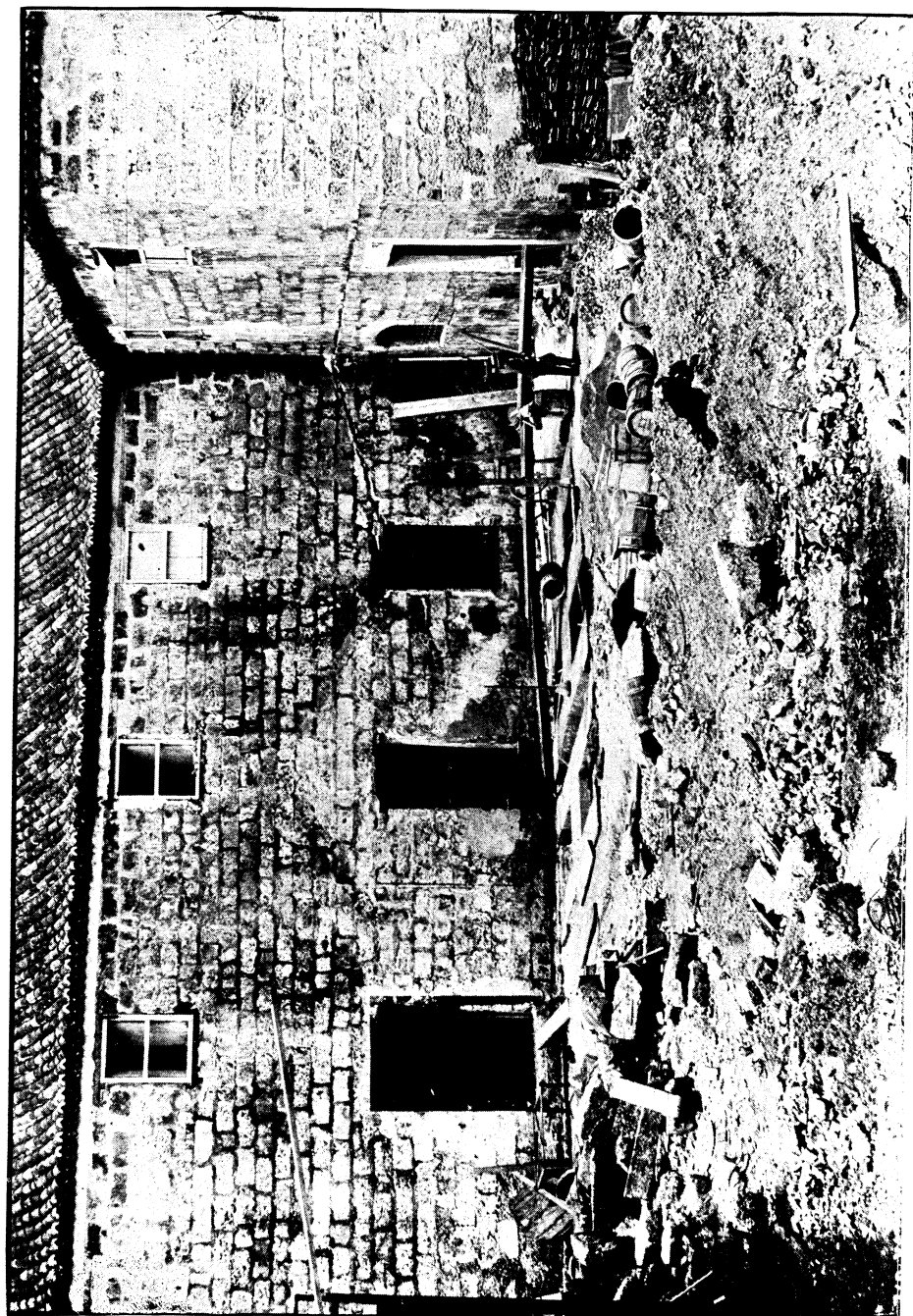
| | |
|---------------------------------------------------------------|-------------|
| Adolph E. Mueller & Co..... | \$11,440.87 |
| Extra bill for placing sink complete in Sisters' kitchen..... | 133.46 |
| Purdy & Henderson..... | 2,216.50 |
| R. Guzman & Co..... | 686.00 |
| Total | 14,476.83 |

Although the improvements at this building were ordered by the division commander solely for sanitary reasons, the economical results are striking.

This institution heretofore purchased its bread. By making its own bread it will save at least \$2,000 per annum. This figure is based upon



ELERZA-ELECTRIC PLANT, STERLING BOILERS. JUNE 13, 1900.



ELECTRIC-LIGHT PLANT—BOILER FOUNDATION.

saving made by Second Army Corps bakery at Camp Meade, Pa., when price of flour was half the prevailing Cuban prices. The installation of steam laundry permitted the abandonment of a large area occupied by an old-fashioned laundry, and the concentration at that point of the various dining rooms, thereby rendering available for classrooms or other purposes space which would cost \$14,000 to provide by new construction, the annual interest upon which at 6 per cent would be \$840.

The director, Dr. Agramonte, is vigorously carrying out the policy indicated by the character of the improvements made, and will make a net saving in wages, etc., of about \$2,000 per annum.

These annual savings of \$4,840 at 6 per cent for forty years are \$72,800, or 220 per cent of cost of improvements.

LA FUERZA ELECTRIC-LIGHT PLANT.

The electric-light plant originally designed for the proposed carcel at the Hospital Militar building, which was abandoned for carcel purposes, was transferred to the old gun room bordering on harbor, of the Cuartel de la Fuerza, for the purpose of furnishing electrical current to the governor-general's palace and to the lieutenant-governor's palace, which buildings are already wired, and have been receiving current from the Spanish-American Light and Power Company.

The plant is an economical one, and consists of 1 100-horsepower and 1 200-horsepower Sterling water-tube boilers; 2 75-horsepower American ball compound engines, direct connected to 2 Westinghouse 50-kilowatt generators; 1 Wheeler condenser, with 300 square feet cooling surface; 1 Cochrane feed water heater; 1 fire pump, 600 gallons per minute capacity; boiler feed pumps; switchboards, etc. Capacity of plant about 1,500 16-candlepower lights. Contract price was \$24,350, the next lowest bid being \$35,497. The government was to construct all foundations.

The change of location from Hospital Militar necessitated alterations in the original plan, and incurred additional expense in handling material on account of the location being in the "ditch" of La Fuerza; and for cable conduit to transmit current to the buildings to be lighted, this cable necessarily being very heavy, on account of the machinery being designed for direct current within the building, instead of for alternating current, which is employed when current is to be distributed to distant points. The contractors rendered an extra bill for \$3,959.82, which was cut \$1,574, the amount allowed being as follows:

| | | |
|-----------------------------------------------|------------|------------|
| New electric work..... | \$1,697.62 | |
| New steam and water piping..... | 820.31 | |
| Extra labor for transfer to new location..... | 400.00 | |
| | | \$2,917.93 |
| Less fixtures..... | 449.00 | |
| Less labor..... | 300.00 | |
| | | 749.00 |
| | | 2,168.93 |
| Commercial profit..... | | 216.89 |
| Total..... | | 2,385.82 |

And in this bill the amount in dispute with the contractor was for \$650, estimated saving in labor, which amount was finally conceded by the department. The contractors are to turn over to the government

all electrical material, except chandeliers, which they had not yet purchased.

Compressible ground was unexpectedly encountered, necessitating expensive foundations, and a wrought-iron base for stack instead of brick.

It being desired to make a park of the La Fuerza grounds, and to restore the original appearance of the fortress, the razing of buildings on harbor front to level of parapet wall is considered, which would necessitate a flat roof for boiler house of steel I-beams and concrete, and the removal of stack to a less prominent position and its adornment. For the same reasons a smoke-consuming device is desirable, and a steam jet is contemplated as most expedient under existing conditions.

These contingencies caused the estimated costs to be exceeded, as herewith shown:

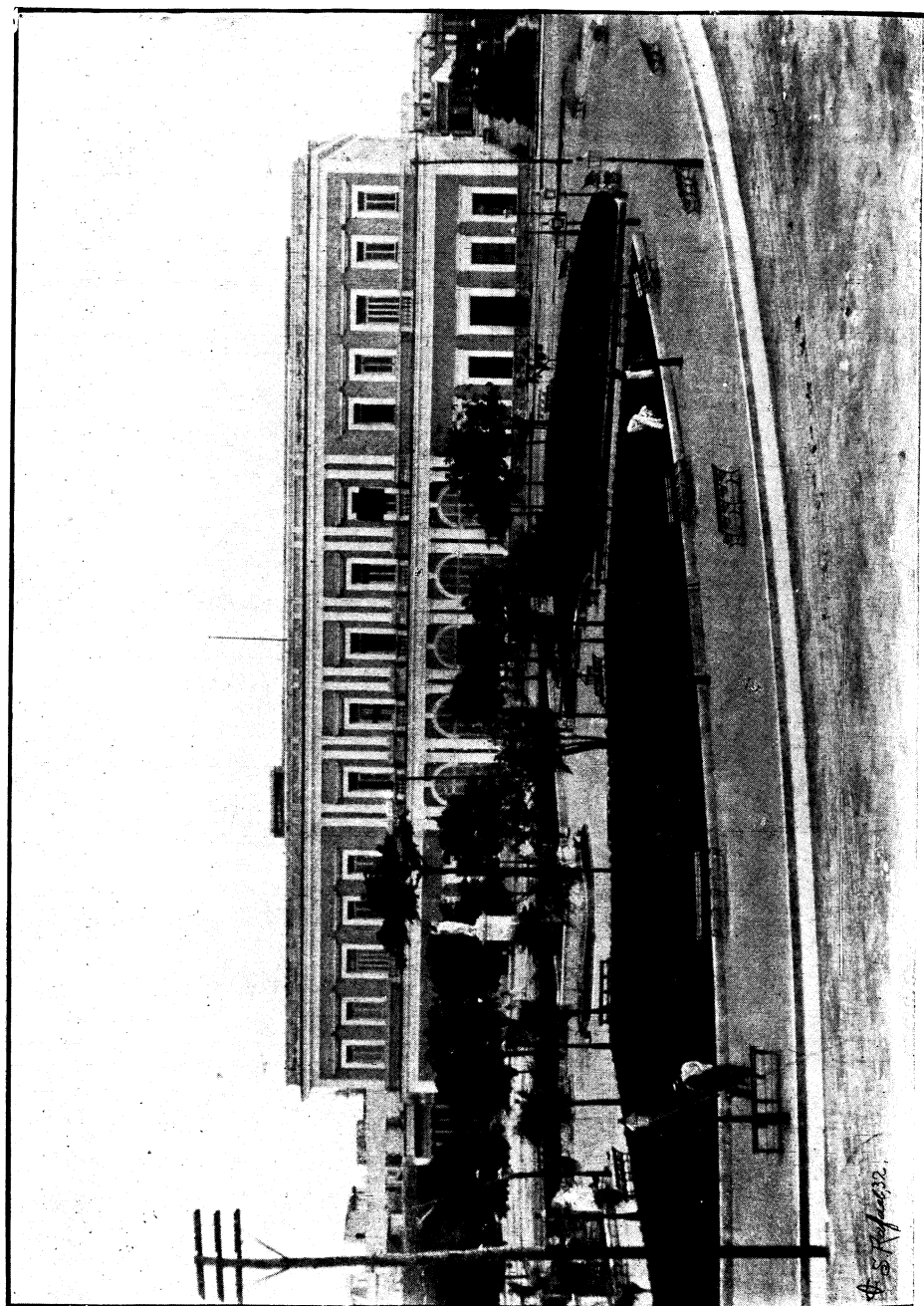
1. Cost to date (including amount of contracts) \$28,553.16

Work yet to be executed.

| | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 2. Moving chimney foundation..... | \$200.00 |
| 3. Chimney adornment..... | 1,055.00 |
| 4. Trolley for coal supply..... | 165.00 |
| 5. Steam jet for smoke consumer..... | 75.00 |
| 6. Newhall Engineering Company's extra bill..... | 2,385.82 |
| 7. Cable from electrozone plant..... | 825.00 |
| 8. Boiler-house roof..... | 1,530.00 |
| 9. Boiler-house floor..... | 350.00 |
| | <hr/> |
| | 6,585.82 |
| | <hr/> |
| | 35,138.98 |
| Less amount of material used in other buildings from Hospital Militar.. | 1,500.00 |
| | <hr/> |
| | 33,638.98 |
| Total allotments..... | 29,350.00 |
| Additional amount required to finish plant in first-class shape..... | 4,383.98 |
| Less amounts of items 2 and 3, which might possibly be omitted..... | 1,255.00 |
| | <hr/> |
| Minimum amount required..... | 3,128.98 |
| Value of electrical goods to be turned over by contractor, and brick not used in chimney base..... | 2,739.02 |
| | <hr/> |
| Net deficiency..... | 389.96 |
| In this connection, it is pertinent to state that the erection of this plant will result in considerable saving in electric-light bills. The two buildings together have about 1,300 lights, which will cost conservatively at current rates per month..... | |
| | 1,300.00 |
| Estimated cost of operation per month..... | 500.00 |
| | <hr/> |
| Difference per month..... | 800.00 |

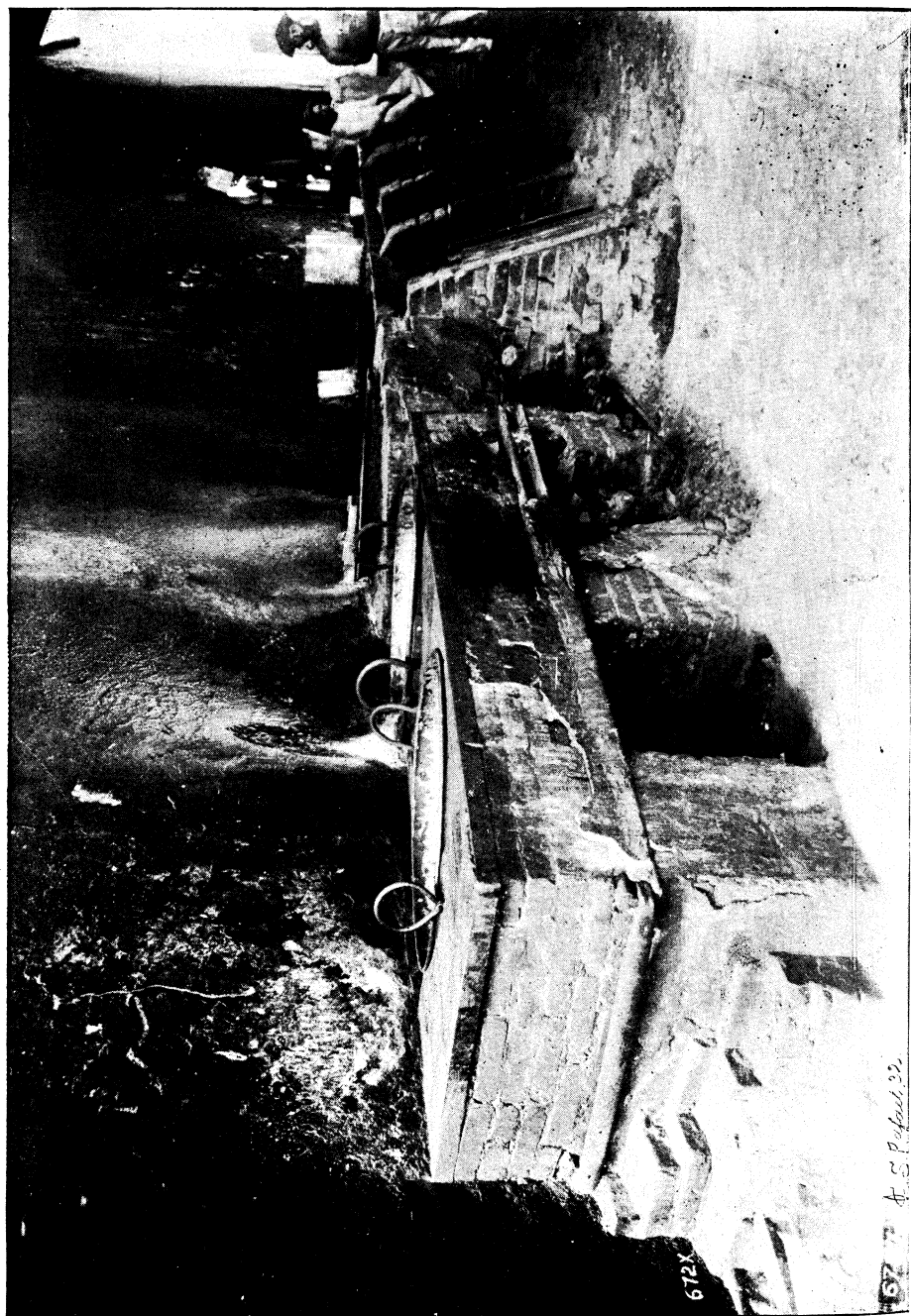
which, when capitalized at 6 per cent for forty years, is \$144,400, or the amount the government would be justified in expending to obtain this saving. The plant will pay for itself in less than four years.

The boiler room is located in the ditch adjoining old gun room on harbor front. The engine room is located within an adjoining room on same level. In order to obtain necessary floor space in engine room, columns were removed and trussed I-beams substituted to support floor above. To form an office for the engineer a partition of expanded metal plaster was erected. Flooring of tongued and grooved yellow pine was constructed. Sewer of vitrified pipe at location of boilers was replaced with iron pipe. Conduits to harbor for suction to con-



HABANA CARCEL.

A. S. Hefner, Jr.

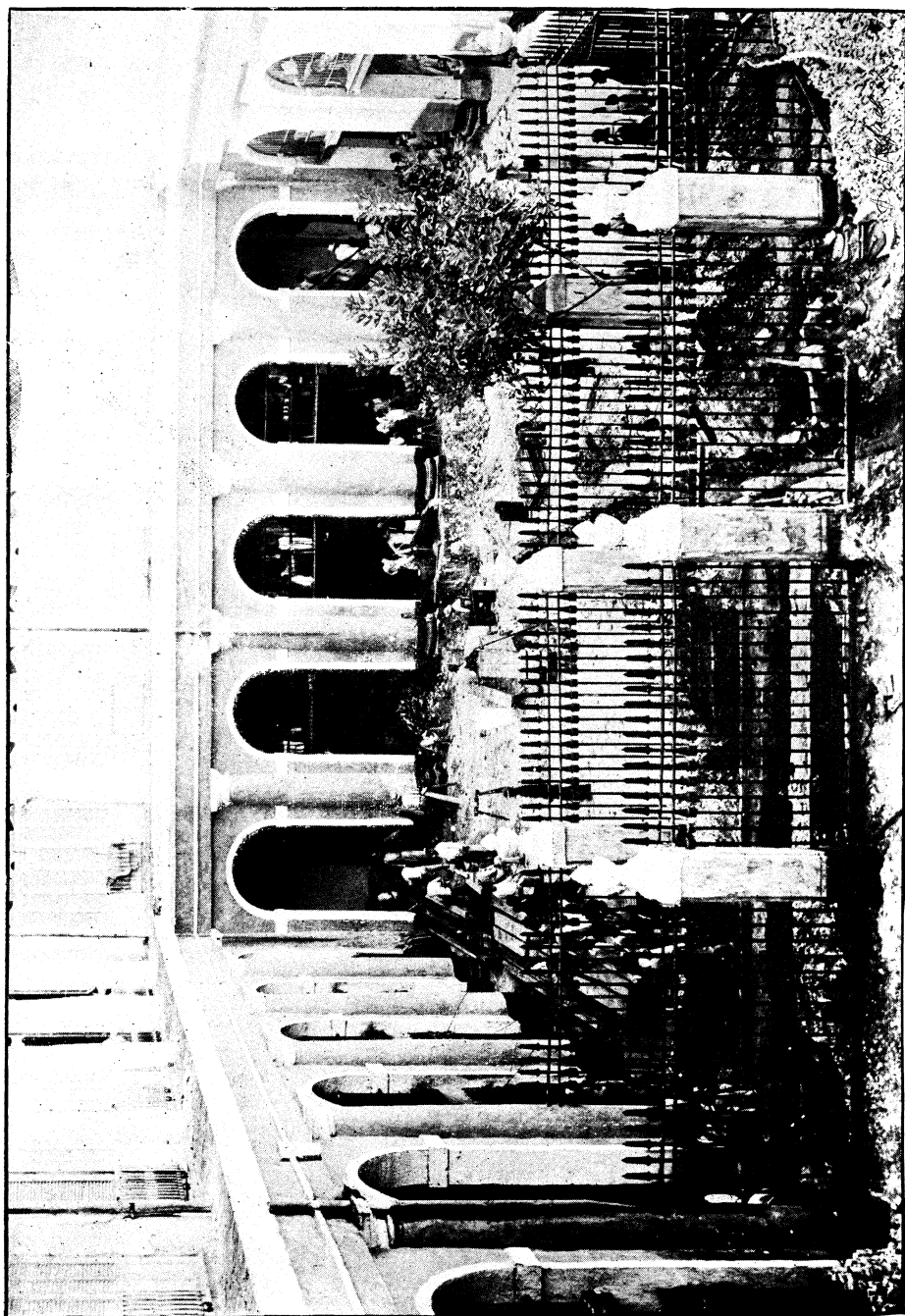


HABANA CARCEL—OLD KITCHEN.

H. S. Popham, 22.

612X

67



HABANA CARCEL. JUNE 28, 1900.

denser, and suction to fire-pump blow-offs, etc., were cut through hard rock and lined with brick.

Foundations for engine and boiler were obtained by excavation to necessary depth. Concrete base, 6 inches deep, was then laid, upon which were placed two layers of railroad iron, bedded in concrete, with concrete carried up to grade line. Rails were drilled to receive fish plates, which were made to order, none other being obtainable. Concrete was of 1 part Dyckerhoff Portland cement, 2 parts sand, and 5 parts broken stone. Surface of concrete was finished to a true level, with finish coat of 1 part sand and 1 part cement.

The necessary handling of material three times added greatly to the cost of the work.

HABANA CARCEL.

The very large building at the foot of the Prado, opposite Morro Castle, is used partly as a presidio or penitentiary, and partly as a carcel or jail, while the south portion of second floor is termed the audiencia, and is occupied by the courts of justice. In order to make this splendid building available for public offices, it was the intention to transfer the jail to the Hospital Militar, where necessary work of conversion had commenced, and to convert Cabaña fortress into a penitentiary, but the abandonment of these two projects made it necessary to place the building in a sanitary condition for its continued occupancy.

Mr. Martinez, assistant state architect, made preliminary plans and estimate for the plumbing and miscellaneous repairs in March, as follows:

| | |
|---------------------------------|---------|
| Cleaning and disinfecting | \$350 |
| Plumbing | 6, 058 |
| Sewers | 1, 630 |
| Water supply | 1, 309 |
| Repairs to roof | 400 |
| Miscellaneous | 1, 056 |
| Total | 10, 803 |

This estimate being correct in the aggregate, it was used in the comprehensive one prepared April 6, as follows:

ESTIMATE.

| | |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| Steam cooking apparatus, shelving, tables, refrigerators, replacing wall with grating, and ventilation | \$6, 300 |
| Steam laundry, including roof over plant | 6, 000 |
| Cleaning and disinfection, plumbing for audiencia, sewers, water supply, repairs to roof, balcony, partitions and doors in court room, and minor repairs, as per project of Mr. Martinez | 10, 803 |
| Night-soil bucket system, basins, urinals, hoppers, sinks, officers' toilet, tearing out old closets, etc | 3, 000 |
| Concrete paving | 3, 600 |
| | 29, 703 |
| Ten per cent for superintendence, false work, scaffolding, unforeseen contingencies and incidentals | 2, 970 |
| | 32, 673 |
| If convict labor is available for rough work of construction, deduct | 1, 200 |
| | 31, 473 |

A complete system of modern plumbing can be installed, instead of bucket system, at an additional cost of..... \$5, 200

Making, if convict labor is not used, a total of 37, 873
And if it is utilized..... 36, 673

The night-soil bucket system was recommended for carcel, but did not meet with approval, and a modern sanitary system of plumbing was ordered throughout.

Plans as adopted comprised good sanitary but plain plumbing for the audiencia, where the plumbing was concentrated as far as possible, only one toilet room being detached, which is located in the judge's retiring room, and contains 1 water-closet, 1 urinal, and 1 basin.

At the north end of the west corridor there are three toilet rooms; one for the public, containing 9 wash-out closets, 5 lip urinals, 3 basins, and 1 slop sink; another for the occupants of the building, comprising 5 water-closets, 3 lip urinals, 2 basins, and 1 slop sink; and the other for females has 3 water-closets and 2 basins. At the north end of east corridor there is a toilet room for lawyers, having 2 closets, 1 urinal, and 2 basins.

Upon the roof or azotea, for the accomodation of the janitors and their families who occupy rooms built thereon, a toilet room was equipped with 3 wash-out closets and 1 slop sink.

For the warden's family, 1 water-closet, 1 basin, 1 tub and shower, and 1 sink were placed in their toilet room.

Three water-closets, 1 urinal, 2 basins, 1 sink, and 3 showers were installed on the first floor to meet the needs of the guards.

The warden's office toilet room has 1 water-closet, 1 urinal, and 1 basin.

All of these fixtures correspond to those described under the head of Casa de Beneficencia.

The prison plumbing consists of toilet rooms in each prison room, which have a capacity of from 30 to 40 prisoners, 20 showers, and 20 linear feet of trough urinal, and 4 water-closets in rear patio, and sinks in corridors of both floors. In each prison toilet room there are generally 2 water-closets, 3 basins, and 1 urinal. Mott's "Hercules," very heavy porcelain bowl, with half S trap and without seat, was specified or its equal. Basins are sectional enameled iron. Urinals are lipped porcelain. Fixtures only are exposed to prisoners, all pipe and connections being placed in a utility corridor, formed by partitions and accessible only to attendants. In the prison, besides the fixtures enumerated, in the rear patio there are 34 water-closets, 20 lip urinals, and 50 basins.

Concrete floors are to be constructed in main patio, rear patio, kitchen, and by the plumber in all toilet rooms.

Sewerage system is of vitrified pipe, laid to a grade of not less than 1 per cent, the diameters varying from 4 to 15 inches. Clean outs, fresh-air inlets, and manholes are properly arranged. Where the sewer enters the structure, iron soil pipe is substituted. Water supply will be pumped around check valve to tank on roof. The steam kitchen comprises 1 portable French wall range, with 5 fires and 5 ovens; 3 4-bushel cast-iron vegetable steamers; 2 80-gallon, full-jacket, cast-iron, seamless kettles; 1 60-gallon copper-jacket kettle; 2 80-gallon jacket coffee urns; 2 8-bushel coal trucks; 1 saucepan rack; 1 coffee roaster; 1 Enterprise No. 16 coffee mill; 1 No. 0 Buffalo meat chopper; 2 No. 19 Van's portable bake ovens; 1 Day's dough kneader;

1 bread proving box; 3 galvanized-iron sinks; overhead trolley and food conveyor; 2 meat roasters, and all necessary pipes, fittings, and connections.

The steam laundry includes: 1 washing machine; 1 steam-jacketed sterilizing washing machine; 1 26-inch centrifugal extractor; 1 100-inch improved steam mangle; 1 15-gallon copper steam-jacketed starch kettle; 1 100-gallon galvanized soap tank; 1 12-draw wood drawroom; 1 75-horsepower Cochrane feed-water heater; 1 25-horsepower vertical engine; 1 40-horsepower standard vertical tubular steel boiler; 1 duplex low-service steam pump; 1 10-inch water-pressure gauge; 1 boiler feed pump, duplex pattern; 1 automatic duplex feed pump and receiver, and all necessary pipes, fittings, and connections.

Comparison of bids for carcel improvements, opened June 5, 1900.

| Bidders. | Kitchen. | Plumbing. | | | | Concrete floor, 2,000 square yards. | |
|------------------------------|----------|-----------|------------|---------|-----------|-------------------------------------------|---------|
| | | Laundry. | Audiencia. | Prison. | Complete. | Price. | Amount. |
| Purdy & Henderson | \$5,000 | ..... | ..... | ..... | \$21,711 | \$1.85 | \$3,700 |
| Van Range Co. | 5,190 | ..... | ..... | ..... | ..... | ..... | ..... |
| American Laundry Co ..... | ..... | \$6,578 | ..... | ..... | ..... | ..... | ..... |
| Mueller & Co ..... | ..... | ..... | ..... | ..... | 23,750 | ..... | ..... |
| Jas. B. Clow & Sons ..... | ..... | ..... | ..... | ..... | 14,754 | ..... | ..... |
| Newhall Engineering Co. | 5,585 | 5,540 | ..... | ..... | ..... | 1.55 | 3,100 |
| A. Brownlee | 5,275 | 7,350 | ..... | ..... | 15,527 | 1.85½ | ..... |
| Bramhall, Deane & Co.¹ | 4,400 | ..... | ..... | ..... | ..... | ..... | ..... |
| Sussdorf, Zaldo & Co ..... | ..... | ..... | ..... | ..... | ..... | 1.7478 | ..... |

¹No check; bid otherwise informal.

Bramhall, Deane & Co.'s bid being informal, and made on their own basis, Purdy & Henderson were awarded contract for steam cooking apparatus.

The steam-laundry contract was awarded to the Newhall Engineering Company, who bid on the Wilson Laundry Machinery Company's type of machine, and the award was so made, but afterwards the Newhall Engineering Company arranged to use the machinery of the American Laundry Machinery Company.

The specifications described the laundry and kitchen machinery at the Casa de Beneficencia, erected by the John Van Range Company and the American Laundry Machine Company, but explicitly stated that the specifications could be varied, at the discretion of the chief engineer, so as not to prohibit the use of any particular manufacturer's line of goods.

The plumbing was awarded to James B. Clow & Sons, who have commenced work with energy, under the management of Mr. Sylvester Scovel.

The prison water-closet, as specified, was changed to automatic flush, enameled-iron bowl, enameled iron seat, commonly known as Clow's "M. 200," this closet being considered equal to the one specified.

Cast-iron partitions were substituted for expanded metal partitions, without increased price. Cast-iron partitions would have been specified in the first instance, had it been deemed possible to have obtained them at the same price as expanded metal plaster partitions.

CARCEL CLEANING.

On March 13, 1900, the following estimate was forwarded of cost of material for cleaning walls and gratings and whitewashing walls of the carcel. Labor to be furnished by prison authorities.

ESTIMATE.

| | |
|------------------------------------------------------------------------------|-------|
| 1,540 pounds alabastine, at 7 cents..... | \$105 |
| 6 dozen whitewash brushes, 6 inches, at \$6 | 36 |
| 6 dozen ship scrapers, at \$6 | 36 |
| 50 feet $\frac{3}{4}$ -inch chain (for cleaning gratings), at 36 cents | 18 |
| Lumber for ladders..... | 100 |
| 9,000 pounds lime for disinfection | 30 |
| 6 dozen galvanized-iron buckets | 36 |
| 6 wine casks, at \$1.50 | 9 |
| 500 pounds dry color, at 2 cents | 10 |
| | <hr/> |
| Ten per cent for incidentals | 38 |
| | <hr/> |
| Total | 418 |

The necessary materials were delivered at the carcel.

REINA BATTERY.

At the request of Major Greble, superintendent of charities, an estimate was forwarded on May 1 for transferring old kitchen of the Casa de Beneficencia to this battery, which is now occupied by the boys' reformatory, removed from Asilo de San Jose.

ESTIMATE.

| | |
|---------------------------------------------------------------------|----------|
| Shed over kitchen..... | \$136 82 |
| Tearing down, transferring, and reerecting brick and ironwork | 61.00 |
| Repairs to ironwork | 27.00 |
| | <hr/> |
| | 224.82 |
| Ten per cent for incidentals | 22.48 |
| | <hr/> |
| Total | 247.30 |

The director of the asylum finally decided that the old kitchen was not desirable, and instead the present kitchen was removed to top incline of east parapet wall, between which and the curtain wall, on a level with the terreplein, a new dining room is located. The army range was reinstalled. Copper kettles were relocated adjacent to cook shed, with brick furnace underneath.

QUINTA DE LOS MOLINOS FENCE.

On June 5 estimate was forwarded for placing in good condition the masonry fence on calle de Carlos III, inclosing grounds of the Quinta de los Molinos and the grounds of the botanic garden.

ESTIMATE.

| | |
|------------------------------------------------------|----------|
| 360 square yards plastering, at \$1..... | \$360.00 |
| 500 squares alabastine calsomining, at 50 cents..... | 250.00 |
| 75 squares painting iron fence, at \$2.50 | 187.50 |
| Incidentals | 79.50 |
| | <hr/> |
| Total | 877.00 |

The plastering has been finished and the painting is being done.

NOTES ON CONSTRUCTION.

A general description of the conditions in which one building was found, before renovation, will apply with equal force to all of them. With the exception of the Hacienda, the Casa de Beneficencia, and the Mercedes Hospital, they were filthy beyond description and generally in bad repair. The sewers were of porous masonry, of open joints, rectangular in section, of slight fall, and sometimes clogged completely with fecal matter. The water-closets, where there were any, were of antiquated type, and installed unsanitarily. In some buildings sewers discharged into cesspools, out of which many loads of night soil were removed. The water supply was inadequate, with leaking fixtures. The roofs were leaky and required a great deal of repairing. In some cases the ventilation was insufficient, and into some rooms the light scarcely ever penetrated.

Disinfection was begun when work on each building was started, and continued during the operation. Lime was used freely on all freshly excavated material, electrozone was sprayed with force pumps over every square inch of accessible area, and bichloride of mercury was used when the building had an unusually bad reputation. Walls and ceilings were thoroughly brushed, washed, and scraped; floors were scrubbed, walls calcimined, and woodwork, doors, and windows were repaired and painted. Generally, a great deal of plastering was found loose, and was replaced.

Vitrified pipe sewers of proper dimensions were built from street sewers to the walls of buildings, and where extended into buildings cast-iron soil pipe was employed. Sewers were laid carefully to a grade calculated to produce a velocity of 3 feet per second. Clean-outs and fresh-air inlets were inserted in sewers at proper points. A sufficient supply of water was obtained by making suitable taps into street mains, and providing for thorough circulation.

The plumbing has been done according to the best United States practices, and of a class to correspond to the use to which the building was to be put. The plumbing is properly trapped, vented, and back aired. Closets are generally porcelain bowl washouts, with hard-wood seat and hard-wood cistern, with copper lining and nickel-plated flush pipe. Closets are set in putty, on brass floor flange, connected with lead bends, which are calked with brass ferrules into hubs of soil-pipe connection. Out of lead bend a lead connection is taken to the 2-inch galvanized-iron revent, which is carried back to stack and extended above roof. All water pipe is galvanized iron. Bath tubs and slop sinks are of first-class enameled iron. Showers are tubular, of tinned copper. Enameled-iron basins are generally used. Urinals are generally of the porcelain-lip type, and sometimes enameled-iron trough with automatic flush.

In calcimining, the walls were thoroughly scraped with ship scrapers, and covered twice with a wash composed of water, lime, color, and either tallow, zinc, or oil. The woodwork, after being thoroughly scraped, was covered with white lead, in linseed oil and color. In toilet rooms enamel paint was used on walls to a height of 12 feet, and on all partitions, to permit washing down with hose.

Masonry, like carpenter and other work into which skilled labor enters, is exceedingly expensive, and, though the natives do their work thoroughly, they do it exceedingly slowly. The sand of this locality

is of a very mediocre quality. The lime, though plentiful, is very liable to be air-slacked and full of clinkers. Quicklime is slacked two weeks before using. Most of the principal parts of the new brick and stone walls have been laid in 1 to 5 of Portland cement mortar, with enough lime added to secure plasticity, which gives the best results, as the local so-called "Cuban cement" lacks uniformity in quality. The brick on the market is of variable sizes and of very poor quality. The building stone is porous and soft. Good hard, flinty stone, however, is plentiful for concrete.

Concrete floors are constructed of 3 inches of concrete, mixed of Portland cement mortar, with sand and rock—1, 5, and 11—topped with a finish coat one-half inch thick of mortar, composed of equal parts of Portland cement and sand. Tile floors are laid in a half-inch bed of mortar, on well-tamped sand or cocoa base.

A close account is kept of all detailed costs of work done either by the government forces or by contractors, in order to keep check on the cost of work and to obtain unit prices for estimating purposes.

The following are the costs of labor, material, and of work in place now prevailing in Habana, which will give a very fair idea of what the American engineer in Cuba has to contend with.

Prices of material prevailing in Habana between January 1 and June 30, 1900. These prices were much higher at the beginning of the American occupation, and were brought to the present reasonable stage by active American competition. The Habana merchants seldom make an effort to secure business, and their policy is exactly opposite to that of the American merchant—"Quick sales and small profits."

| | | |
|-------------------------------------|--------------------------|--------|
| Chloride of lime..... | per pound.. | \$0.04 |
| Bichloride of mercury..... | do..... | 1.10 |
| Lime..... | { per 100 pounds.. | .45 |
| | { per cubic feet.. | .25 |
| Plaster of paris..... | per barrel, 400 lbs.. | 3.75 |
| Hair..... | per pound..... | .10 |
| Sand..... | per cubic meter..... | 2.20 |
| Cement (Cuban)..... | per barrel, 286 lbs.. | 2.50 |
| Cement (Portland)..... | per barrel, 400 lbs.. | 4.25 |
| Cement (Rosendale)..... | per barrel, 200 lbs.. | 2.60 |
| Cuban brick, \$19 per 1,000..... | per cubic yard..... | 6.75 |
| American brick, \$17 per 1,000..... | do..... | 9.25 |
| Broken stone..... | per cubic meter..... | 2.30 |
| Building stone..... | do..... | 6.50 |
| French roof tile..... | per thousand..... | 70.00 |
| Round Spanish roof tile..... | do..... | 35.00 |
| Common floor tile..... | do..... | 33.00 |
| Mosaic floor tile..... | do..... | 78.00 |
| Common marble floor tile..... | per 100 square feet..... | 75.00 |
| Alabastine..... | per pound..... | .06½ |
| Turpentine..... | per gallon..... | .75 |
| White lead..... | per pound..... | .11 |
| Linseed oil..... | per gallon..... | .75 |
| Japan drier..... | do..... | 1.75 |
| White zinc..... | per pound..... | .11 |
| Colors (ground in linseed oil): | | |
| Green..... | do..... | .25 |
| Blue..... | do..... | .35 |
| Yellow..... | do..... | .25 |
| Colors (dry): | | |
| Green..... | do..... | .18 |
| Blue..... | do..... | .10 |
| Red..... | do..... | .08 |
| Yellow..... | do..... | .03 |

| | | |
|------------------------------------------------------------|-------------------------|--------|
| Expanded metal for plastering..... | per square yard.. | \$0.30 |
| Expanded metal for concrete..... | do..... | .45 |
| Wooden lath..... | per 1,000 linear feet.. | 5.00 |
| Heavy manhole covers | | 18.00 |
| Vitrified pipe: | | |
| 4-inch..... | per linear foot.. | .14 |
| 6-inch..... | do..... | .21 |
| 8-inch..... | do..... | .28 |
| 12-inch..... | do..... | .53 |
| 18 inches..... | do..... | 1.05 |
| 24 inches..... | do..... | 1.75 |
| Coal..... | per ton.. | 4.00 |
| Asbestos..... | per pound.. | .05 |
| Structural iron shapes..... | do..... | .04 |
| C. L. columns..... | do..... | .04 |
| Corrugated iron..... | do..... | .06½ |
| Plain window grating..... | per square foot.. | 1.00 |
| Louvre blinds..... | do..... | .50 |
| Common panel doors..... | do..... | .40 |
| Common windows..... | do..... | .40 |
| Lumber: | | |
| Ordinary studding and framing..... | per M feet B. M.. | 30.00 |
| Flooring, dressed, one side..... | do..... | 38.00 |
| Flooring, dressed, two sides..... | do..... | 45.00 |
| First-class white pine, dressed for doors and windows..... | do..... | 80.00 |
| Plumbing fixtures, as described: | | |
| Tubular showers..... | | 3.00 |
| Wash-out closets..... | | 18.50 |
| Bath tubs, 5 feet..... | | 36.00 |
| Laundry tubs..... | | 26.00 |
| Slop sinks..... | | 25.00 |
| Lip urinals, ordinary..... | | 5.00 |
| Trough urinals..... | per foot.. | 6.00 |
| Solder..... | per pound.. | .25 |
| Pig lead..... | do..... | .04 |

Discounts on plumbing material are as follows:

Soil pipe, in New York, 60 and 5; in Habana, 40. Lead material, in New York, 40; in Habana, 30. Galvanized pipe, in New York, 60 and 10; in Habana, 55. Galvanized fittings, in New York, 55 and 10; in Habana, 50. Valves, etc., in New York, 60; in Habana, 30. Soil-pipe fittings, in New York, 70; in Habana, 40. Brass goods, in New York, 60; in Habana, 40.

LABOR.

Cuban climatic conditions prevent the securing of the same results from labor as are expected in the United States. The average American laborer or mechanic is not of much utility in Cuba until he passes through the acclimation period. If he stands this ordeal he becomes a fairly good man. For instance, a bricklayer who should lay about 1,500 bricks per day in the United States will lay about 900 in Cuba. The average Cuban bricklayer will lay from 300 to 400 bricks per day.

The Cuban carpenter is a cabinetmaker, and makes very little headway on the framing of buildings, etc. As a comparison, in erecting studding for an ordinary frame building he will tack and plumb each particular piece with a spirit level, when an American would frame all on the ground and erect rapidly in sections, plumbing ends only.

One American plumber in Habana requires thirteen days to complete a toilet room of 1 water-closet, 1 bath tub, 1 basin, and 1 slop sink, when he would do the same work in New York in eight days. I have seen no native sanitary plumbers.

An ordinary Cuban will average 12 square yards of concrete floors per day, and the American, 20 square yards.

It is not intended to convey the idea that all Cuban workmen are inferior to all American wage-earners, for there are some very poor specimens of Americans here, and there are some excellent Cubans at work. Cuban mechanics do excellent work, but are very slow.

Rate of prevailing wages.

| | | |
|----------------------------------------------------|-------------|-----------|
| Assistant engineer in charge of subdepartment..... | per month.. | \$250.00 |
| Mechanical engineer..... | do..... | 125.00 |
| Draftsmen..... | do..... | 100.00 |
| Chief clerk..... | do..... | 120.00 |
| Stenographer..... | do..... | 100.00 |
| General foremen..... | do..... | 125.00 |
| Clerks and timekeepers..... | do..... | 75.00 |
| Foremen: | | |
| First-class..... | per day.. | 4.00 |
| Second-class..... | do..... | 3.00 |
| Capataces or bosses (gang)..... | do..... | 2.00 |
| Carpenters..... | do..... | 2.00-3.00 |
| Masons..... | do..... | 2.00-3.00 |
| Plumbers..... | do..... | 5.00 |
| Helpers, first-class..... | do..... | 3.00 |
| Helpers, second-class..... | do..... | 2.00 |
| Laborers: | | |
| First-class..... | do..... | 1.00 |
| Ordinary..... | do..... | .84 |

The following is a schedule of the approximate costs, in place, of the several classes of work in Habana. These are slightly high, but safe for estimating purposes:

| | | |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|------------|
| Excavating and hauling..... | per cubic yard.. | \$0.70 |
| Brick masonry, laid in Cuban cement..... | do..... | 15.00 |
| Brick masonry, laid in lime mortar..... | do..... | 13.00 |
| Portland concrete masonry..... | do..... | 9.00 |
| Masonry used in Habana buildings..... | do..... | 12.00 |
| Mortar: | | |
| With lime (2 sand to 1 lime paste)..... | do..... | 9.00 |
| With Cuban cement (3 to 1)..... | do..... | 9.50 |
| With cement, Portland (3 to 1)..... | do..... | 13.50 |
| With cement, Portland (1 to 5)..... | do..... | 10.00 |
| Ordinary carpenter work from \$40 per 1,000 feet, B. M. according to class of work to..... | | 70.00 |
| Concrete floors, as previously described..... | per square foot.. | .20 |
| Expanded metal plaster, (including metal, plaster, and labor) per square yard..... | | 1.50 |
| Common doors and windows..... | per square foot.. | .50 |
| Tile roofing, including rafters and sheathing..... | do..... | .26 |
| Tile roofing, complete, composed of tile top surface, mortar bed, cocoa base, tile ceiling, board strips, and floor beams—construction used in all Cuban houses..... | per 100 square feet.. | 52.00 |
| Flat roof of top surface, made of concrete and expanded metal, flat arch, l-beams, etc., now being used extensively in the United States per square..... | | 63.00 |
| Flat roof of tar and gravel, laid on sheathing supported by rafters, with slight pitch, forming an air space over ceiling, composed of pine sheathing, supported by pine beams, same as is extensively used in Chicago, complete..... | per square.. | 37.00 |
| Floor of pine beams and 1½-inch tongued and grooved flooring, complete per square..... | | 29.00 |
| Cost of expanded metal plaster work, including studding, plaster, and metal on both sides..... | per square.. | 44.00 |
| Same, plaster on 1 side..... | do..... | 26.00 |
| Cost of ordinary shelving of yellow pine per M feet, B. M..... | | 75.00 |
| Scraping..... | per square yard.. | \$0.03-.10 |

Plumbing installed (fixtures as previously described):

| | |
|------------------------------------------------------------------------------------------------------|-------------------------|
| Ordinary water-closets (including all connections) | \$60. 00 |
| Baths (including all connections) | 70. 00 |
| Slop sinks (including all connections) | 35. 00 |
| Enameled iron sectional basins (including all connections) | 30. 00 |
| Showers (separate, including all connections) | 20. 00 |
| Trough urinals (including all connections)..... per linear foot.. | 18. 00 |
| Detachable iron basins (including all connections) | 38. 00 |
| Sewers, 4, 6, and 8 inch vitrified pipe or cast iron soil pipe, including appurtenances, about | per linear foot.. 1. 00 |
| Four-inch galvanized iron down spouts, and 8-inch gutters | do.... .30 |
| Electric-light wiring and fixtures..... per light.. | \$10. 00-\$14. 00 |
| Ordinary painting (3-coat work)..... per square yard.. | .30 |
| Calceining, two coats | do.... .06 |
| Vitrified tile floor, including cocoa base mortar bed and tile | do.... 1. 50- 2. 50 |
| Water-tube boilers | per horsepower.. 30. 00 |
| Dynamos..... | per kilowatt.. 35. 00 |
| Compound condensing engine..... | per horsepower.. 35. 00 |
| Structural iron work, excessively high, averaging about..... | per pound.. .12 |

The renovation of public buildings, under the engineer department, Department of Habana, cost, per cubic foot of contents, below the eaves, as follows:

| | |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Compostela St. Orphan Asylum..... | \$0. 03½ |
| Old post-office building..... | .06 |
| Belascoain Barracks..... | .02 |
| Hospital militar, with iron work | .07 |
| Hospital militar, no iron work | .05 |
| Cost of building of tile roof, wooden truss, expanded metal plaster walls, brick piers, concrete floors..... | per cubic foot.. .15 |
| Ordinary warehouse buildings, corrugated-iron roof, wooden truss, wooden floors..... | do.... .09 |
| Buildings fitted up for hospital purposes, having tile roof, novelty siding, inside ceiling, wooden floors 2 feet off ground, supported by piers, surrounded entirely by porches..... | per cubic foot.. .13 |
| Cost of disinfection (labor 6 cents, bichloride of mercury and hydrochloric acid 12 cents)..... | per 100 square feet.. .18 |

Data pertaining to the granting of official authority for the performance of work outlined in this report:

Casa de Beneficencia: By third indorsement on civil file, Division of Cuba, No. 6122. Chief engineer's file No. 59. Date, February, 10, 1900.

Recogidas: Verbal authority of division commander, and referred to in civil file, Division of Cuba, No. 1236, chief engineer's file No. 132. Date, March 1, 1900.

Belascoain Barracks or Medical College: Second indorsement, on civil file, Division of Cuba, 1236. Chief engineer's file No. 155. Date, April 5, 1900.

Reina Battery or Asilo de San Jose: Verbal authority of division commander. Subject referred to in chief engineer's file No. 59. May, 1900.

La Fuerza electric plant: Third indorsement of civil file, Division of Cuba, No. 4203. Chief engineer's file. Department of Habana, No. 7327-3. Date, November 6, 1899. Plant transferred to La Fuerza by verbal authority of division commander.

La Fuerza archives: First indorsement on civil file, Division of Cuba, No. 1236. Chief engineer's file No. 139. Date, March 26, 1900.

Quinta de los Molinos fence: Second indorsement of civil file, Division of Cuba, No. 1236. Chief engineer's file No. 204. Date, June 9, 1900.

Carcel improvements: Second indorsement on civil file, Division of Cuba, No. 1236. Chief engineer's file No. 125. Date, April 10, 1900.

Carcel cleaning: Second indorsement on civil file, Division of Cuba, No. 1236. Chief engineer's file No. 125. Date, March 21, 1900.

OFFICE OF MUNICIPAL ARCHITECT.

[Mr. Luis de Arozarena in charge.]

The municipal architect is charged with the inspection of all building operations in the city of Habana, including the work of construction and repair. It is his duty to see that such work is done in accordance with the municipal ordinances of construction. He also inspects buildings of all kinds throughout the city, and recommends such improvements as may be necessary, or demolition whenever buildings are considered in an unsafe or ruinous condition.

From July 1, 1899, to June 30, 1900, 7,120 expedientes have been received, and 7,225 have been dispatched. These refer to the different works that were inspected, some of them more than once, and are as follows:

| NEW WORKS. | | REPORTS—continued. | |
|-----------------------------------------------|-------|--------------------------------------------------|-----|
| New buildings..... | 191 | Stables..... | 54 |
| Additional stories..... | 46 | Hotels, restaurants, and coffee houses..... | 196 |
| Additional rooms..... | 200 | Circus and merry-go-rounds.. | 14 |
| New fronts..... | 25 | Charcoal shops..... | 71 |
| Interior sheds..... | 73 | Dairy and cow stables..... | 64 |
| New walls..... | 72 | Vermicelli factories and box factories..... | 9 |
| Minor works..... | 145 | Grocery stores..... | 140 |
| | 752 | Laundries..... | 85 |
| REPAIRS. | | Tin and blacksmith shops.... | 19 |
| Roofs or floors..... | 844 | Hay stores, miscellaneous goods stores..... | 12 |
| Doors or windows..... | 309 | Tannery and veterinary shops..... | 15 |
| Fronts..... | 73 | | 679 |
| Balconies..... | 64 | Foundry and iron works..... | 5 |
| Staircases..... | 42 | Transport agency and commission stores..... | 14 |
| Whitewashing and painting.. | 812 | Gas, electric, and steam machines..... | 32 |
| Minor repairs..... | 439 | Bakeries..... | 26 |
| | 2,583 | Meat shops..... | 12 |
| FINISHED WORK. | | Kiosks..... | 66 |
| Inspections of new works..... | 210 | Lumber yards and mechanic shops..... | 14 |
| Inspections of repairs made.. | 627 | Cigar and cigarette factories.. | 27 |
| Inspections of works made for industries..... | 188 | Carpenter shops, depot of material..... | 56 |
| | 1,025 | Inspections for liquor stores and breweries..... | 22 |
| DENUNCIATIONS. | | INSTALLATIONS OF INDUSTRIES. | |
| Works without licenses..... | 183 | Fruit shops..... | 140 |
| Ruinous houses for demolition | 127 | Sweetmeat factories..... | 10 |
| Ruinous houses for repairs... | 151 | Ice factories..... | 5 |
| Unsanitary state..... | 93 | Omnibus companies..... | 4 |
| Wooden works..... | 72 | Pastry shops..... | 23 |
| Fallings of buildings..... | 14 | Coffee mills..... | 4 |
| Sundry violations..... | 157 | Cooper shops..... | 2 |
| | 797 | Hardware stores..... | 13 |
| REPORTS. | | Poultry stores..... | 5 |
| Fraud in installations of water | 121 | | |
| Estimates..... | 67 | | |
| Demolitions made..... | 52 | | |
| Sundries..... | 576 | | |
| Complaints of fees..... | 119 | | |
| | 935 | | |

INSTALLATION OF INDUSTRIES—contd.

| | |
|--------------------------|----|
| Restaurants | 15 |
| Second-hand stores | 4 |
| Wine shops | 6 |
| Bicycle shops | 2 |
| Cattle pens | 2 |
| Stone quarries | 2 |
| Shoe stores | 3 |
| Match factories | 4 |

INSTALLATION OF INDUSTRIES—contd.

| | |
|------------------------------------|-----------|
| Theaters | 2 |
| Mineral-water establishments | 3 |
| Printing establishments | 5 |
| Sundries | 53 |
| | <hr/> 581 |
| Total | 7,352 |

Since July 1, 1899, the following work has been finished:

Municipal Vivac: The work of tearing out unnecessary masonry, as well as rotten timber, was completed. General repairs, painting, and whitewashing throughout the building were also completed. Gas was installed.

School, Jesus del Monte, Nos. 261 and 263: The work of masonry was continued and that of repairs to roofs and floors.

School, Estevez street, No. 45: The work of demolition continued, as well as that of repairs.

Aldecoa Hospital: The work comprised demolition of some parts of the building, masonry construction, carpenter work, and repairs. Plumbing was installed. Installation of crematories and of a laundry plant was carried out.

Santovenia estate (Hermanitas de los Pobres): The work comprised replacing rotten timbers, general repairs, and cleaning of the building.

The following work was superintended by this department:

Diputacion del Mercado de Colon: Whitewashing and painting.

Casa de Recogidas: Floors were repaired.

Tacon market (stalls 24, 25, and 26): Drains were cleaned out and flagstones repaired and reset.

San Nicolas street, No. 242: The front wall was shored.

Fernandina street, No. 23: This house was demolished.

San Jose asylum: Leaks in gas pipes repaired.

Cristina market: Leaks in roof repaired.

Corrales street: Plans prepared to establish building line.

Casa Blanca: Plans prepared to establish building lines.

Carmelo ward (Vedado): The building lines corners of Nineteenth and Twelfth, Nineteenth and Twenty-eighth, Nineteenth and Thirtieth, Twenty-first and Twelfth, Twenty-first and Twenty-eighth, Twenty-first and Thirtieth, Twenty-first and Thirty-second, and Eighteenth and Nineteenth streets were marked.

San Lazaro Littoral: Plan is being prepared.

Cuartel de Bomberos Municipales: Cement floors were repaired.

No. 135 Vives street: House was demolished.

San Pedro and Jutziz streets kiosk: This kiosk was demolished.

Building lines at Calzada de Concha, Cerro, and Jesus del Monte: Some building lines were marked in these streets.

Building line at E street (Vedado): The building line of Mr. Ruiz Cadalso's house was marked.

The following works are still being done:

Tacon market: Half the vegetable tables of the longitudinal aisles are being cut off, and the fish counter hoists are being repaired.

Colon market: The fish tables are being repaired and modified.

Besides the work under the superintendence of this department, the following work was done by contract:

Cuartelillo de bomberos, 39 Obrapia street (for police headquar-

ters): The work comprised demolition of wall, construction of kitchen, repairs to floors, installation of water-closets, painting, general repairs, and gas pipe installation.

Plaza del Vapor, booths 11 and 12: Masonry construction, painting, and installation of plumbing.

Plaza del Vapor: The installation of 8 iron enameled water-closets and 6 urinals. Screens and partitions were placed around water-closets.

Casa de socorro, Egido street: The work done consisted of masonry and painting and installation of plumbing.

Santovenia estate (Hermanitas de los Pobres): The work comprised general repairs, new timbers, cleaning, and installation of water-closets and water pipe.

Cuartel de bomberos municipales: The work done comprised the construction of stables and iron mangers, cement floors, and a coal depot. Cement floors of stables were planked over.

Quinta de higiene: The work done consisted in the building of a room for a laundry plant, tile and cement flooring, and general repairs.

Casa de socorro de la 1^a Demarcacion: The work done consisted in the construction of an operating room, stable, and general repairs.

Jefatura de policia: A prison cell was constructed.

Colon market: The work done was the zinc lining of the vegetable tables.

The following works are unfinished:

Colon market: Installation of marble slabs and water-closets—marble work, \$2,500; plumbing, \$1,340.32; total, \$3,840.32.

SURVEY OF FORTIFICATIONS.

Mr. Joseph A. Sargent, assistant engineer, in charge from July 1, 1899, to June 30, 1900. Organization of field and office forces on June 30, 1900.

One topographical field party: Mr. R. E. Bateson, transitman, one recorder, three stadia rodmen, one back flagman, and one helper.

One secondary field party: Mr. E. J. Westerhouse, transitman, and two level rodmen.

One permanent fortification survey party: Assistant engineer in direct charge, one draftsman, and two chainmen.

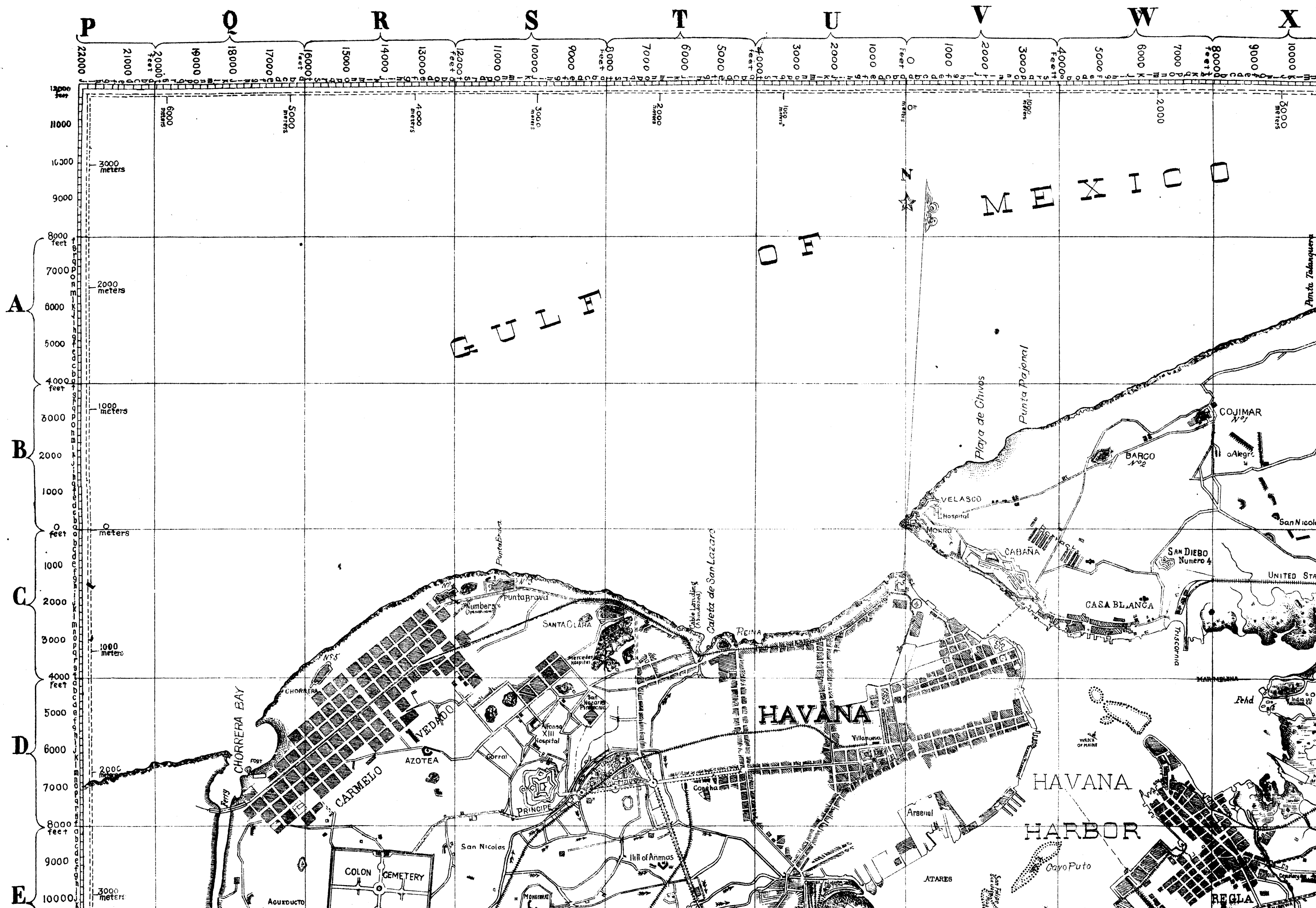
Office force: Señor Esteban T. Pichardo, expert draftsman, one computer and clerk.

Photographic force: Mr. Charles E. Doty, official photographer, one assistant photographer, and one helper.

SURVEY OF TEMPORARY FORTIFICATIONS, DEPARTMENT OF HABANA.

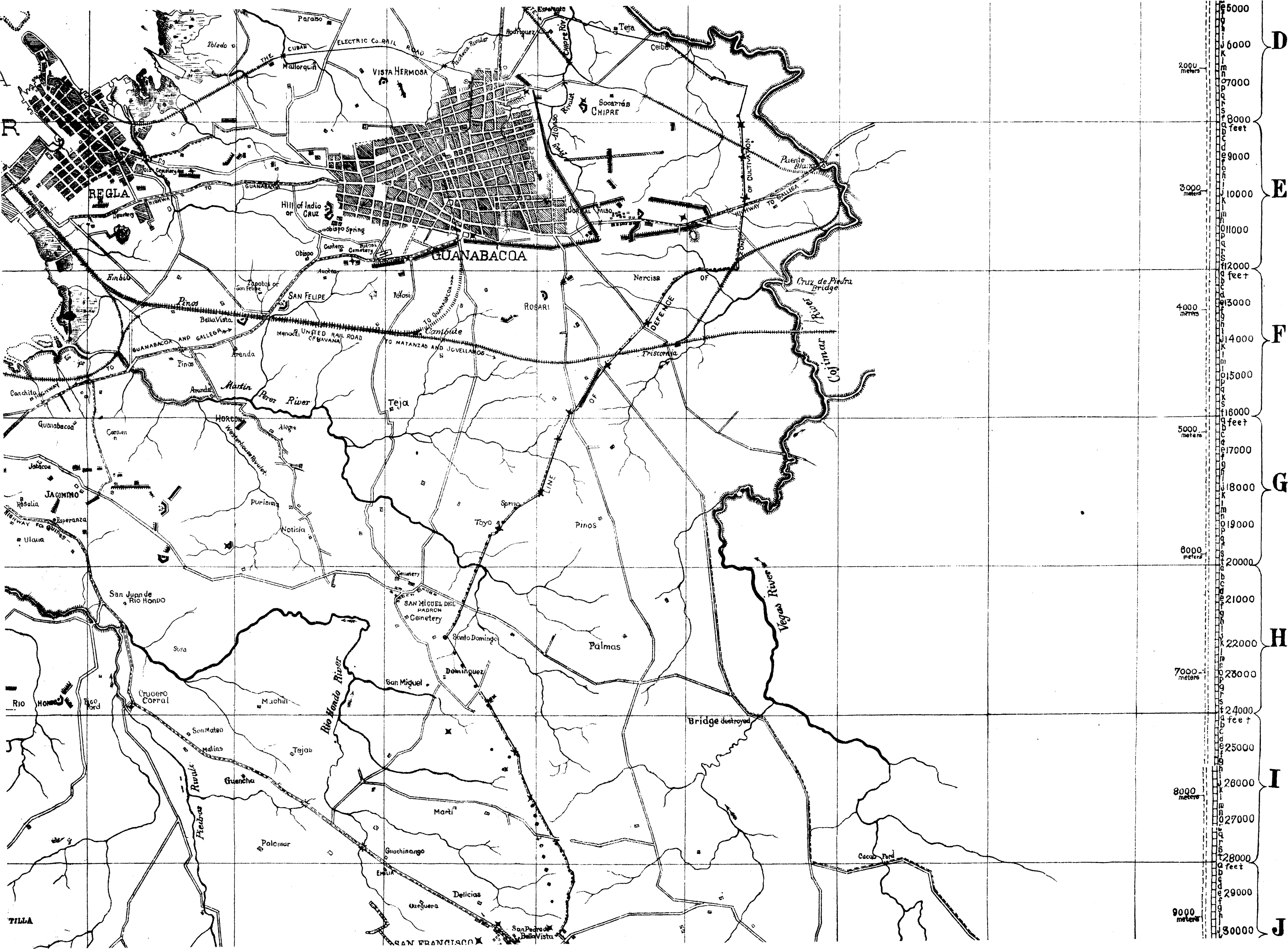
GENERAL DISCUSSION OF DETAILS.

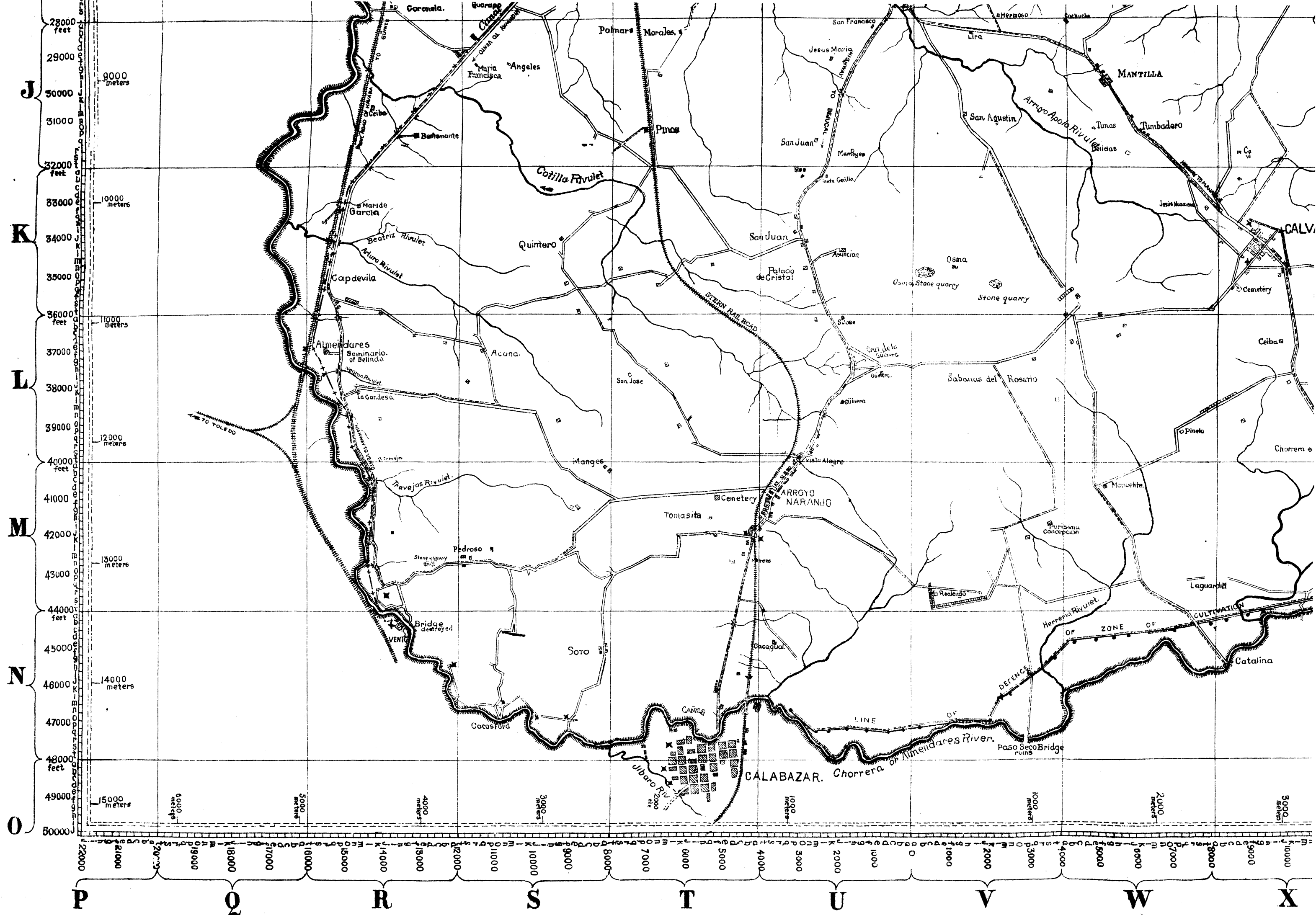
For numerous details leading up to the organization of field and office forces of this survey and for a brief of field work up to June 30, 1899, see the Annual Report of the Commanding General, Department of Habana, Fiscal Year ending June 30, 1899. A detailed report of the work done, including a general tabulation of data in book form, was submitted to the department commander May 16, 1900, accompanied by a map of the department, a portfolio of plans and section of the more

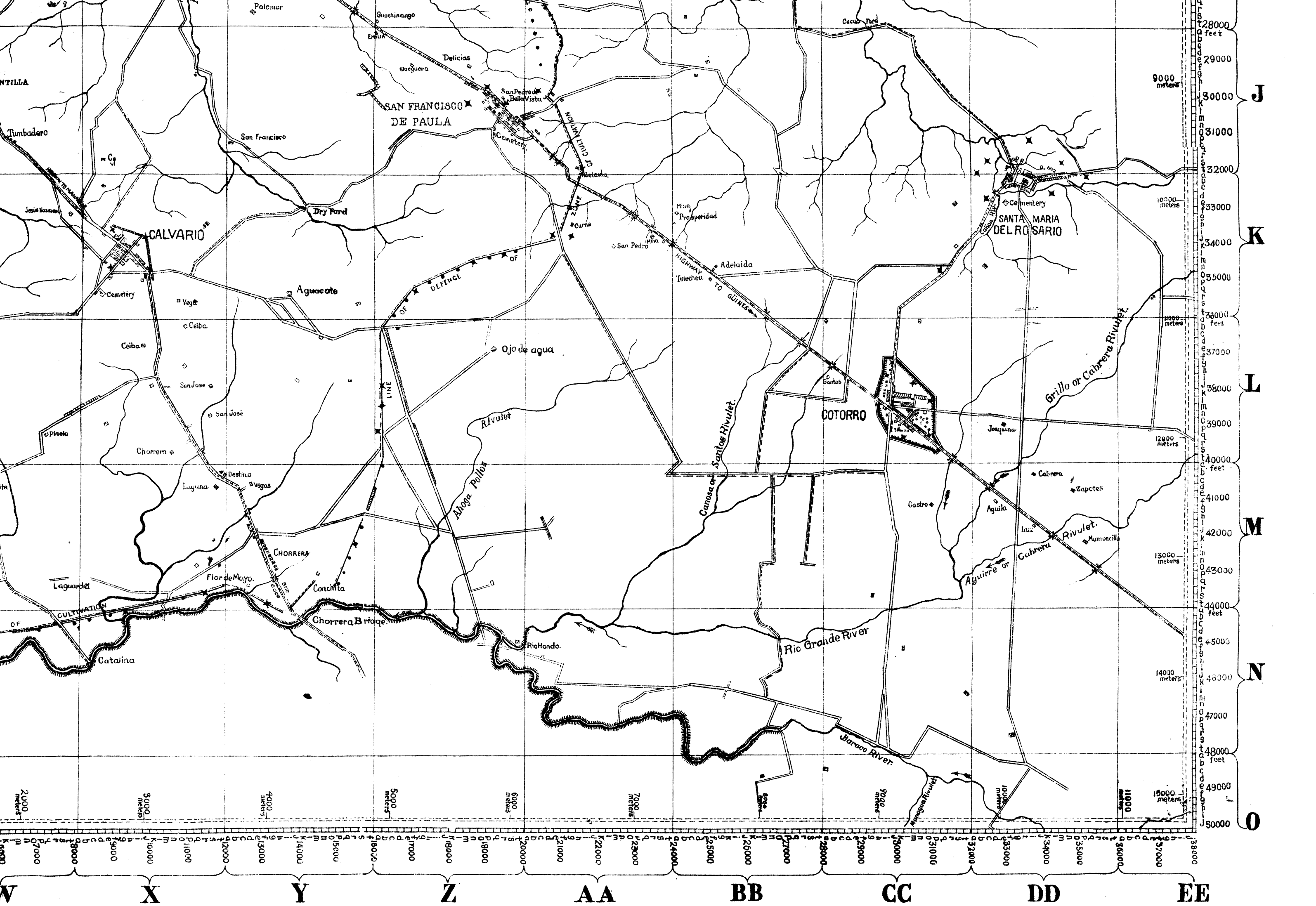


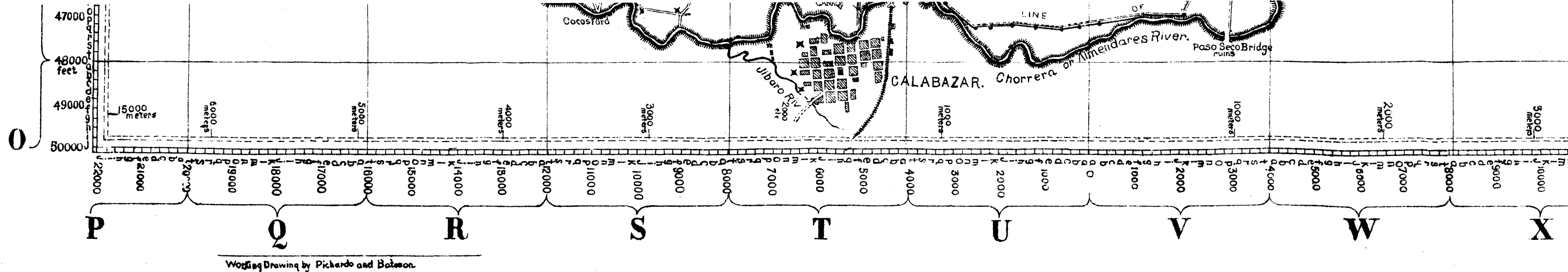












LOCATIONS OF MOST IMPORTANT FIELD WORKS,

THE MORRO TOWER, LYING IN A TRUE MERIDIAN, TAKEN AS ORIGIN.

THESE ARE TRIANGULATION POINTS.

For complete data on Field Works, see general tabulation accompanying Report of Survey of Temporary Fortifications,
Department of Havana.

| NAME WHERE KNOWN. | POSITION BY MARGINAL CROSS INDEX. | CLASSIFICATION. | LATITUDE. | | DEPARTURE. | |
|----------------------|-----------------------------------------------|-----------------|----------------|----------------|---------------|---------------|
| | | | NORTH FEET. | SOUTH FEET. | EAST FEET. | WEST FEET. |
| "Ingenito" | Aa-AAm. | Battery | 4002.60 | | 22356.00 | |
| | Ae-Yq. | Stdq. Trench | 4936.80 | | 15217.80 | |
| | Am-AAb. | Ppt & Trench | 6603.89 | | 20373.42 | |
| | Bk-Xt. | Ppt & Trench | 105.72 | | 11820.09 | |
| | Bb-Xi. | Redoubt | 215.11 | | 9790.38 | |
| San Pedro | Bb-Yk. | Battery | 337.53 | | 14164.82 | |
| | Bc-Xc. | Battery | 560.07 | | 8817.95 | |
| | Bd-AAI. | Trench | 972.84 | | 21768.58 | |
| | Bc-AAe. | Blk House | 922.28 | | 20428.13 | |
| | Bg-Yo. | Btry & Trench | 1500.03 | | 14499.43 | |
| "Ingenito" | Ca-Yc. | Redoubt | 166.04 | | 12464.80 | |
| | Ca-Xr. | Battery | 53.50 | | 11449.85 | |
| | Cb-Xh. | Battery | 364.29 | | 9551.37 | |
| | Co-Ze. | Redoubt | 2835.57 | | 10925.34 | |
| | Dh-Rd. | Redoubt | 6040.72 | | | 12778.78 |
| Vista Hermosa | Do-Yt. | Redoubt | 6920.79 | | 15988.25 | |
| Chilpre | De-AAg. | Redoubt | 7637.50 | | 21274.40 | |
| Animas | Bg-Tm. | Lunette | 9206.70 | | | 6434.30 |
| Acueducto | Bl-Qb. | Battery | 10354.31 | | | 16366.91 |
| Monserat | Bl-Sl. | Lunette | 10238.61 | | | 9980.10 |
| Loma Cruz | Bm-Ym. | Rdbt & Btry | 10405.01 | | 14483.30 | |
| Corral Pazo | En-AAm. | Rdbt & Trench | 10668.67 | | 22763.44 | |
| Rosario | Ed-AAm. | Redoubt | 12780.09 | | 20238.15 | |
| San Felipe | Ff-Vg. | Battery | 13175.44 | | 13321.58 | |
| | Fg-Qa. | Ppt & Trench | 13298.50 | | | 16051.63 |
| | Th-Uk. | Trench | 13537.17 | | | 2002.81 |
| San Felipe | Ph-Yb. | Redoubt | 13484.60 | | 12221.50 | |

| NAME WHERE KNOWN. | POSITION BY MARGINAL CROSS INDEX. | CLASSIFICATION. | LATITUDE. | | DEPARTURE. | |
|----------------------|-----------------------------------------------|------------------|----------------|----------------|---------------|---------------|
| | | | NORTH FEET. | SOUTH FEET. | EAST FEET. | WEST FEET. |
| Mordazo | Pl-Rt. | Ppt & Trench | 14304.91 | | | 15840.33 |
| | Ph-Zq. | Ppt & Trench | 13409.38 | | 19274.48 | |
| | Gb-Rl. | Battery | 16268.63 | | | 15869.11 |
| | Gc-Ro. | Redoubt | 16529.34 | | | 14821.55 |
| | Gd-Qd. | Art. Ppts | 16767.98 | | | 16724.64 |
| La Tropical | Gd-Wg. | B. H. & Stq. Tr. | 16718.18 | | 5299.02 | |
| | Ge-Qp. | Redoubt | 16812.30 | | | 19103.70 |
| | Gk-Xg. | Stq. Trench | 18012.30 | | 9350.07 | |
| | Gm-Un. | Battery | 18652.53 | | | 2705.55 |
| | Gn-Fe. | Redoubt | 18663.53 | | | 20813.92 |
| Buena Vista | Gn-Xk. | Battery | 18618.03 | | 10122.28 | |
| San Miguel | Go-Ua. | Btry & Trench | 18926.20 | | | 147.21 |
| Ceiba | Gt-Qs. | Redoubt | 19805.32 | | | 19718.14 |
| La Cantera | Gt-Xk. | Redoubt | 19995.00 | | 10054.50 | |
| Cruz del Padre | Ha-Tq. | Redoubt | 20095.00 | | | 7302.40 |
| Bello | Hb-Rp. | Redoubt | 20349.48 | | | 15051.72 |
| Mazo | Ht-Ta. | Redoubt | 21798.23 | | | 4057.35 |
| | Hm-Ud. | Ppt & Trench | 22576.89 | | | 714.52 |
| Timón | Hn-Vb. | Redoubt | 22735.00 | | 251.00 | |
| | Hh-Vf. | Ppt & Trench | 25058.16 | | 1042.39 | |
| "Ingenito" | Ht-Wa. | Redoubt | 23887.59 | | 4019.39 | |
| Rio Honda | Ht-Wr. | Redoubt | 23807.00 | | 7405.40 | |
| San Francisco | Jl-Zm. | Blk House | 30274.38 | | 18441.95 | |
| Rosario | Jp-LDb. | Blk House | 31174.25 | | 55591.09 | |
| Cotorro | Lk-CCp. | B. H. & Trench | 38127.89 | | 31002.61 | |
| Vento (temporary) | Ms-Rl. | Blk House | 43698.38 | | | 14212.52 |
| Vento (permanent) | Nc-Rh. | Blk House | 44521.66 | | | 14096.90 |

MAP SHOWING LOCATIONS OF TEMP

ERECTED BY THE SPANISH I

THE LAND DEFENSE OF 1897-1898.

DEPARTMENT OF HAVANA.

OFFICE OF CHIEF ENGINEER.

W^m M. Black,

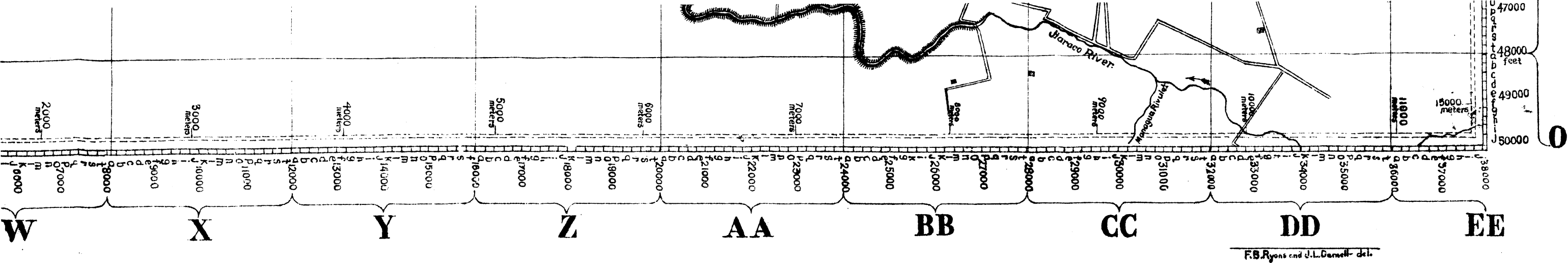
Maj., Corps of Engrs., U. S. Army.

April 10th, 1900.

IMPORTANT TRIANGULATED POINTS OTHER THAN FIELD WORKS.

| DESIGNATION. | POSITION BY MARGINAL CROSS INDEX. | LATITUDE | | DEPARTURE | |
|----------------------------------------------|-----------------------------------------|----------------|----------------|---------------|---------------|
| | | NORTH FEET. | SOUTH FEET. | EAST FEET. | WEST FEET. |
| S. W. corner Cajamar Port. | Ak-AAe. | 6151.01 | | 20979.68 | |
| E. Flag Pole San Diego or No. 4 | Cf-Wo. | | 1161.00 | 6956.51 | |
| Main Flag Pole Cabaña. | Cj-Vp. | | 1958.69 | 3048.89 | |
| Vertex Machina Tripod. | Dg-Vr. | | 5818.99 | 3416.04 | |
| Dome Regia Church. | Un-Wp. | | 6746.12 | 7060.62 | |
| Iron Flag Pole S. E. cor Principe Castle. | Dq-Sh. | | 7304.48 | | 8557.07 |
| Church dome Guanabacoa. | Bf-Zl. | | 9031.95 | 17726.45 | |
| Main Flag Pole Atarés Castle. | Bo-Uh. | | 10806.31 | | 1402.42 |

| DESIGNATION. | POSITION BY MARGINAL CROSS INDEX. | LATITUDE | | DEPARTURE | |
|----------------------------------------|-----------------------------------------|----------------|----------------|---------------|---------------|
| | | NORTH FEET. | SOUTH FEET. | EAST FEET. | WEST FEET. |
| Church Cross Jesus del Monte | Gg-Uk. | | 17245.42 | | 2111.24 |
| Church Dome San Francisco de Paula. | Jl-sp. | | 30332.13 | 19021.61 | |
| Church Dome Sta. Maria del Rosario. | Kb-DDg. | | 32284.37 | 38393.67 | |
| Church Cross Calvario | Kl-Xf. | | 34236.15 | 9106.88 | |
| Tall Chimney Capdevila | Kp-Rs. | | 35064.92 | | 15741.69 |
| N. E. Corner Chorrera Bridge. | Nb-Yk. | | 44228.57 | 14031.72 | |
| Church Cross Calabazar. | Ob-Tq. | | 48300.06 | | 5366.01 |



LOCATIONS OF TEMPORARY FIELD WORKS

LOCATIONS OF TEMPORARY FIELD WORKS

DEFENSE OF HAVANA, 1897-1898.

Temporary Field Works were located by triangulation and referred by rectangular coordinates to Morro Tower as Origin. Main Highways were traversed by stadia. Minor roads and minor detail were sketched by Batson Board method. Other data chosen from original Spanish sources, after consulting with Sr. Esteban T. Pichardo.

Joseph A. Sargent,
Asst. Engr.,
IN CHARGE OF SURVEY.

CONVENTIONS.

- Batteries.
- "Closed" Redoubts.
- "Open" Redoubts (Lunettes).
- Block Houses.
- Trenches—shaded in Rear.
- Detached Artillery Parapets—Light line in front.
- Parapets—with Trench.
- Sentry Posts.
- Stone Wall.
- Railroads.
- Worked Roads.
- Unworked Roads.
- Impassable Cart Roads, Used as Horse Trails.
- Horse Trails.
- Aqueducts.
- Cut Channels.
- Mangrove Marsh.
- Marsh.
- Railroad Station.
- Street Railroads.

BOUNDARY.

For authority defining boundary of Department of Havana, see G. O. No. 191, A. G. O., December 30, 1898, Par. 1.

MAGNETIC DECLINATION.

Observing from many points in September, 1899, with a common K. & E. transit needle, the declination was found to be N. 2° 50' E.

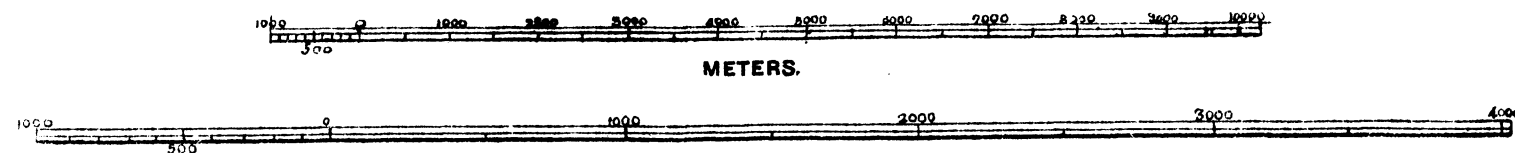
MARGIN.

Capital letters on margin, with indicated sub-minors, are for cross-reference. Each of the smallest marginal sub-divisions=200 feet. These letters also give alphabetical order for indexing tabulations of recorded locations.

SCALE 1 inch=1600 feet.

FEET.

METERS.



important temporary field works, 84 in number, and a set of photographs of the fortifications and of the ground commanded by each important work. All independent temporary fortifications shown on the map of the department have been classified and tabulated with miscellaneous remarks, and their respective locations are recorded. Numerous prominent points that may be used as future landmarks have also been indexed and tabulated, with their respective positions recorded. Detail drawings and photographic views have been indexed and tabulated.

Authority.—Verbal orders were given by the chief engineer on April 18, 1899, to begin compiling a map of the Department of Habana. Directions were modified from time to time to meet exigencies arising from inaccurate or incomplete original data, as shown later.

Compilation of data.—When the map was begun it was believed that it could be compiled from original Spanish surveys. Some thirty-odd maps were selected from the general archives of Cuba and an attempt was made to reduce them to a common scale. (See p. 210, Annual Report of the Commanding General, Department of Habana, fiscal year ending June 30, 1899.) As the platting progressed, it was found that most of these maps contained gross inaccuracies as regards detail, though in some cases the general courses of streams seemed to have been meandered with fairly accurate results. Along the south boundary of the Department of Habana no two maps agreed. In some instances the same point, as shown on separate maps, when platted to a common scale, failed to agree in position by a difference of half a kilometer or more. When this was discovered each detail upon which there was no check was weeded out, and field work was begun with a tertiary triangulation system as a basis, upon which to plat the acceptable compiled data. The development of the city of Habana and its immediate suburbs was effected almost wholly by compiling from the maps of Sr. Esteban T. Pichardo and the Spanish map entitled "Division de Defensa de la Plaza de la Habana," made by Spanish engineers. River courses are located on the new map by accepting the best platted courses as reduced from two or more original maps to a common scale, thence by adjusting these accepted courses between triangulated positions by the method of proportionate corrections, each triangulated position having been first referred by rectangular coordinates to Morro tower with reference to a true polar meridian. All other data on this map not referred to above was obtained by original field work, as discussed under following subheadings:

Tertiary triangulation.—For brief remarks on progress made in triangulation up to June 30, 1899, see pp. 208-211 of the Annual Report of the Commanding General, Department of Habana, 1899, where it is shown that it is necessary to do most of the field work first, and afterwards establish measured bases. When the work was begun, ordinary Keuffel and Esser field transits with verniers reading to the nearest minute were the best instruments available. As the work was carried through the entire summer, and since the field party made no distinctions in working conditions, but worked continuously from early morning until sunset, through hot, sunshiny, and cool, cloudy weather, it is believed that the results obtained by this system of triangulation are excellent, considering the working time involved and instruments used.

The initial base line was measured from the corner of Paseo de

Tacon and Calzada de Infanta south along Infanta, and all due care was taken to insure accuracy in keeping with working conditions. The tape used was an excelsior steel tape of 100 feet in length with a small spring balance graduated from zero up to 10 pounds pull, sold by Keuffel and Esser and certified by them to be standard at 62° F., with a tension of 61 pounds, when supported through entire length, having the coefficient of expansion, $-.000006$. In measuring the base line a straight line was first projected by the transit along Infanta street, where the slope of the street was most uniform. The tape was supported its entire length along the uniform slope and distances were measured between pencil points on spike heads. The spikes used were driven flush with the slope, the summation of all subslope distances between pencil points being taken as the total slope distance of the base line. Wye levels were then run, showing elevations of all spike heads to the nearest one hundredth of a foot, and the versin or slope correction necessary to obtain horizontal distance was found for each subdistance above named. The summation of all slope or versin corrections was then subtracted from the total slope distance and the result taken as the horizontal distance for one trial measurement of the base line. Sun temperatures were considered and obtained from the United States Weather Bureau Office in Habana for the hours in which the work was done. Four trial measurements of the base line were made as indicated above, alternate trials being measured in opposite directions; i. e., two measurements were made running north over the base line and two were made running south. After making four trial measurements of the base line the difference between the maximum and the minimum measurement was found to be 0.135 of 1 foot. The mean of the four trial measurements gave 3,414.82 feet for the accepted length of the base line.

It may be of interest at this point to note that in the ordinary working temperature of this climate, which seldom runs more than 20° F. and frequently not more than 10° F. above standardizing temperature, the expansion of the tape due to increase of temperature tends to neutralize the contracting effect due to twist or torsion when tape is supported on a street surface and given the standardizing pull. This fact was not more than casually noticed in measuring this base, since no attempt was made to reduce the measurement to a geodetic nicety.

In the triangulation field work, when two stations of a large triangle were noticeably different in elevation, the respective angles of that triangle were read by repetition and telescopic reversion. All other angles of importance were read by direct repetition from left to right and angles were repeated, until with minute vernier transits the sum of the angles of each triangle as read in the field lacked less than one-half minute of adding to be geometrically correct.

In the office work nothing more than triangular adjustment of angles was attempted, and each triangle so adjusted was solved independently. When all the triangles were solved, however, large polygons were formed by selecting the sides of different triangles. These polygons were so chosen as to practically make a skeleton, covering the area embraced by the Department of Habana. The azimuth of each side of these polygons was obtained with reference to true north by referring to the field notes, and the location of each vertex in these polygons was found by calculating its position by latitude and departure with reference to Morro tower as origin. In calculating latitudes

and departures the computers traced the polygon, found the closing error, and later balanced each polygon by the ordinary method of proportionate corrections. The closing error of these polygons ranged from a maximum of $1/8000$ to a minimum of $1/20000$, which closing error is less than the writer had expected to find, knowing that the work had progressed through all kinds of weather.

As an arbitrary check upon the triangulation system, a second base was measured in the east part of the department. Beginning near where the United States military railroad crosses the Guanabacoa-Cojimar highway, this base was measured north along the slope of the highway in a manner somewhat similar to the measurement of the initial base on Infanta street. This base as measured by the steel tape, with versin sloped corrections applied, was found to be 3,399.53 feet in length. The length of this base was then calculated by triangulation, triangles having been carried across the department from the initial base on Infanta street, and the following results were obtained:

Comparison between length of arbitrary measured base on Guanabacoa-Cojimar highway and calculated values of same base calculations carried from initial base on Infanta street by several subsystems of triangles.

| | Feet. |
|--------------------------|--------------|
| Measured length | 3,399.53 |
| Calculated lengths | (a)—3,397.22 |
| | (b)—3,398.51 |
| | (c)—3,400.45 |
| | (d)—3,397.85 |

It is believed that these results may be taken as evidence that the tertiary triangulation system was reduced to an accuracy well in keeping with working conditions.

Observation for azimuth.—In September, 1899, from the transit point on the hill of the Jesuits, observations on Polaris at eastern elongation were taken to secure true azimuth. In observing for azimuth a small lantern flame was set directly beneath the star at eastern elongation at a point more than one-half mile from the transit. Three observations were taken in this manner by method of setting on the star with telescope alternately direct and reversed. The mean position of these points, no two of which differed in position a readable amount on the horizontal vernier, was considered as being directly underneath the star at elongation. No angles were read at night; the instrument was set up the day following the observation over the point occupied the night before, and angles were read from the point of elongation, allowance being made for the star's azimuth.

From the observation for azimuth taken as above described the azimuths of all lines in the triangulation system were obtained. As a check upon the above-described observation, it is found that the Spanish engineer, Albear, in 1874, observed the azimuth passing through the iron lightning rod on the southeast corner of Principe Castle and the center of Morro tower to be $52^{\circ} 20' 30''$. The survey observations make the same azimuth $52^{\circ} 19' 51''$, a difference of $39''$. This difference is scarcely scaleable on a map having a scale of the map under discussion.

Temporary fortification.—Positions of principal temporary fortifications shown on the map under discussion were obtained by triangulation and platted by using rectangular coordinates as described in the discussion of tertiary triangulation. Conventions used are believed to

be self-explanatory and they, in each case, are platted to show the front. Soon after the Spanish evacuation the natives began destroying the temporary field works. In many instances it would seem as if the field works were wantonly destroyed, for numerous magazines and casemates were torn to pieces without use being made of the timbers. Generally, however, the timbers from the parapets, magazines, and casemates, and the barbed wire of the entanglements have been used to good advantage by the native farmers.

When the field survey was begun it was believed that it might be possible to show the telephone lines that had formerly connected the different fortifications. This could not be done, as the telephone lines were found to have been destroyed, occasional fragments only remaining. Interviews with the natives seemed to show that the temporary field works had been well connected by telephone; but this source of information can not be very reliable.

Attention is invited to the "line of defense of zone of cultivation," shown on this map as following the south and east sides of the Department of Habana. This line was located by "Batson board" sketching, combined with some prismatic compass work. Field sketches were adjusted at frequent intervals by proportionate corrections to fit between points of the tertiary triangulation system. This line of defense consists of a rough stone wall with protected sentry stations made by semicircular piles of rubblestone placed from 100 to 300 yards apart. This wall follows very nearly a military crest, so as to command as much ground as possible. At intervals from one-half to three-fourths of a mile along this line large protected outposts were established in places most convenient for the posting or concentration of sentinels. The purpose of this continuous defense seems to have been largely to detect the approach of an invading force nearing Habana. The number of temporary fortifications shown on this map may be briefly summed up as follows:

LOCATIONS MADE BY TERTIARY TRIANGULATION.

| | |
|---------------------------------------------------------------|-----|
| Redoubts | 23 |
| Batteries | 14 |
| Detached artillery parapets | 6 |
| Blockhouses | 63 |
| Independent trenches and parapets supported by trenches | 116 |
| Total | 222 |

The above enumeration does not include 201 blockhouses and sentry boxes in the "line of defense of zone of cultivation," nor 7 others located by stadia method.

On the map a field work has been termed a battery only when the preponderance of gun banks or gun platforms and artillery magazines seem to indicate that field artillery was most largely depended upon, with infantry used sparingly as artillery support. Where infantry and artillery have been combined to be complementary to each other the work has been termed a "redoubt," "open" or "closed," as the case may be. Where possible the old Spanish names have been ascertained and tabulated in connection with marginal cross-reference index. All field works having proper Spanish names represent noteworthy types of temporary fortifications, and are situated at points giving excellent command. It may be that in some cases the military crests

of fortified hills have been selected with poor judgment, but as a usual thing the rolling hills surrounding Habana afford such excellent command of adjacent ground that any field work erected on these hills would be formidable to an attacking force. As types of field works the three Ingenitos, San Pedro, Rosario, Chipre, Timon, La Cantera, Loma de la Cruz, El Mazo, Cruz del Padre, Bello, Ceiba, La Tropical, and defenses of the village of Cotorro are noteworthy.

Roads.—Constructed roads were traversed by stadia method and platted by azimuth, the results being adjusted between triangulated points. Natural roads, trails, etc., were sketched by using "Batson board" and prismatic compass, and the field sketches subjected to the same proportionate correction as the stadia traverse of constructed roads.

Magnetic declination.—In this survey the magnetic compass was ignored except as a check upon transit work, or in sketching minor details, or tracing minor roads. It was noticed that when outside the magnetic influence of Habana the magnetic compass could be used to good advantage in field sketching, with little or no deviation due to local attractions.

Conventions.—Care has been taken to make all conventions used on this map self-explanatory. It is sometimes difficult to make sharp distinctions between batteries and redoubts, since very poor classification was found in the available Spanish data. In each case a study of the detail drawing was made before adopting any one convention for a specific fortification. Many of the natural roads and trails are being opened or closed by the farmers; therefore it is not possible to show such routes in stable position; but an endeavor has been made to show all public and private roads of importance by well-defined conventions.

Boundary of the department.—The boundary of the Department of Habana, fixed by paragraph 1, General Orders, No. 191, Adjutant-General's Office, December 30, 1898, is found to be very definite with the exception of the two clauses: "Thence along the Rio Grande to near its head; thence north via Santa Maria del Rosario to the headwaters of the Rio de las Vegas." It is exceedingly difficult to locate the headwaters of the Rio Grande or the Rio de las Vegas, owing to the numerous unnamed forks of these streams.

Detail drawings.—The 59 sheets of detail drawings embrace details of 84 distinct types of field works. The triangulation point by which fortifications are located on the department map is shown on each drawing in its relative position and is marked "transit point." It is believed that these detail drawings are self-explanatory and that they may be readily compared with the detail and panoramic photographs. Marginal cross-reference slips were pasted on each sheet and blue print. The respective sheets were assorted in their portfolios so that the index slips may be read alphabetically from top to bottom. The tabulation of photographs is arranged as nearly as possible in the same alphabetical order as these drawings.

It should be observed that the marginal cross-reference index serves the double purpose of alphabetical arrangement of any number of points desired, and also, by mere inspection of the map, gives the location by latitude and departure of points indexed to the nearest 200 feet.

Panoramic and sectional photographs.—These form a complete set of panoramic and detail photographs, showing all ranges and details of construction of field works that could be photographed with effect.

This set of photographs has been tabulated by marginal cross-reference index as far as possible in conformity with the tabulation of detail drawings.

Miscellaneous work.—Since July 1, 1899, the photographer engaged in taking the detail and panoramic views pertaining to the temporary fortifications has been called upon at frequent intervals to take detail and panoramic views pertaining to construction and reconstruction of work done in Habana and its vicinity. Since this photographic work was sandwiched between regular work done on the fortification survey, and since the photographer often carried along work for several subdepartments at the same time, no attempt was made to distinguish the amount of time devoted to any one subdepartment. In each case when photographs were finished they were submitted as per order of the chief engineer.

Between December 1 and December 10, by order of the acting chief engineer, an instrument man, with one and sometimes two assistants, was detailed to do a small amount of work at La Cabaña in connection with the preparation of plans for utilizing that fortification.

Topographical survey of the vicinity of Habana.—On December 18, 1899, the chief engineer approved an outlined scheme to develop a topographical survey of the territory covered by the "Map of the Department of Habana." Contours are to be developed by stadia method, and the whole topography of the region covered is to be projected upon the tertiary triangulation system as a basis. As work was completed on the survey of the temporary fortifications, when men could be spared from the survey, they were put to work getting things ready for the topographical survey. On March 18, Mr. Bateson, transitman, with four helpers, began regular work by first establishing concrete monuments at the principal triangulated positions of the department of Habana. Each monument has a rubblestone foundation about 2 feet below the ground line, a neat cement cap with a copper bolt in the center of the cap, the top being nearly a foot above the ground line. Extreme care has been taken to have the rubblestone foundation and the concrete body of each monument thoroughly tamped. It is believed that these monuments will insure the saving of much valuable time for the field parties, since they, being triangulated points, will afford permanent means of obtaining fixed origins and termini for topographical belts, developed by stadia method. It may be remarked here that the location of these monuments was found to be necessary, since a certain class of people seem to take great pains to destroy all temporary transit points that they can find. Painted triangulated tripods were erected over these monuments to afford frequent checks for azimuths in the stadia survey to follow. As a part of the work preliminary to the stadia survey, a base line 630 meters in length was measured along the United Railroad on a tangent between the Palatino road and the Almendares River. Four independent measurements were made, using small nails driven in a solid hub to designate the measured stations. Over this base the observations for the purpose of securing stadia interval factor were made.

In the inauguration of the work of the stadia survey party, the taking of topographical notes was begun on the Hill of Jesuits, with a view of extending the work to the east around Habana Harbor, in the same order as the late survey of temporary fortifications was conducted. Center lines were projected from the Hill of Jesuits, Hill of

Animas, and Principe Castle, and their side topography taken as the lines progressed. The result is that up to date the field party has completed the taking of topographical notes of the territory bounded on the south by Cerro, on the east by Infanta street, and on the north by a line running east and west through Principe Castle, with the work now progressing south and west of the Hill of Jesuits. More rapid progress will be made after the work in the suburbs of Habana is completed, as the details in the country will be less numerous. This work is being done with a C. L. Berger & Sons engineers' transit, horizontal vernier reading to the nearest 20" direct, which should insure a very satisfactory degree of accuracy.

To enhance the value of the topographical survey, Y levels are run sparingly to establish bench marks at the origin and terminus of each topographical surveyed belt, thereby avoiding the accumulation of any errors otherwise unavoidable in the stadia survey. Bench-mark elevations established by the water and sewer department in different parts of the city of Habana, Cerro and Jesus del Monte, certified to be correct according to the present accepted datum plane, are being used in the work of carrying Y levels along with the progress of the stadia survey party. In each case, level lines are checked to guard against avoidable errors.

In the office, work on the skeleton drawing of the topographical survey is well under way from data already on hand. This includes the coast line, harbor line, part of the city of Habana, a few rivers, roads, and numerous minor details. Tables have also been prepared giving distance values for all possible stadia rod readings, based upon the interval factor secured from the numerous observations over the measured base as already referred to. At present the office force is engaged in the reduction and platting of topographical notes as they are handed in.

Prominent fortification survey.—Early in the month of May, 1900, in compliance with orders from the chief engineer, an examination was made of the plans and records of the permanent fortifications with a view of determining what might be required to complete the plans. Beginning with the coast batteries, it was discovered that most of the plans were projects of the batteries before the same were built, and that the details as constructed differ from what they appear to be on the original plans. It was also found that the plans dated later than the dates of the constructions of the batteries differ in numerous details from the batteries as they now stand. Work was begun by establishing triangulation points on the different coast batteries for the determination of south points and reference points to be used in making plans of the fortifications as they exist. South points for the right guns of the batteries west of the harbor have been established and the work of measuring in the details well begun. So many discrepancies have been discovered that it was found necessary to run a few simple traverse lines to show interior details.

Financial statement for the department of survey and fortifications, from July 1, 1899, to June 30, 1900.

EXPENDITURES.

| | |
|----------------------------------------|-------------|
| For employees (salaries) | \$10,261.64 |
| For materials and minor expenses | 2,177.02 |
| Total | 12,438.66 |

| | |
|---------------------------------------------------------------------------------------|-----------|
| Outstanding liabilities incurred prior to June 30, 1900, including June pay roll..... | 1,958.33 |
| Total expenses for fiscal year..... | 14,396.99 |

Attention is invited to the fact that the photographer did miscellaneous work as reported earlier, and that expenses due to this miscellaneous work done in connection with other subdepartments is included in the above financial statement.

GENERAL REMARKS.

Public works.—In accordance with the adopted policy, the public works of the island, excepting those directly affecting sanitation in garrisoned towns, are being turned over to the department of public works, in measure as that department is prepared to receive them. That department has now a good plan of organization, which has sufficient elasticity to adapt itself to the volume of work which may be allotted to it, and it has a good working set of regulations for the conduct of the works. In personnel it is weaker than is desirable. The number of competent engineers of Cuban birth is very limited, and many of the best of them are in private practice, where the pay is greater than the government can offer. The general feeling in the island is strongly against the employment in public office of any excepting Cubans, and unless this feeling is disregarded in the higher interest of the general good, the department will be fatally handicapped for some years.

Roads.—The entire island area is divided into municipalities, each under an ayuntamiento which holds its sessions in the principal towns. No clear distinction can be made between the state works and those of the municipalities. In the past, certain roads have been declared state roads and cared for by the state, even where they passed through and formed the principal street of a town. The remaining roads were classed as provincial or municipal, and were or were not cared for by the provinces or by the municipalities. Generally they were neglected, and at present they are practically impassable in the wet season. As the interests of the cities or towns and the interests of the rural communities are not necessarily identical, it would seem that the existing political divisions are faulty as applied to public work. It is well known that, to obtain the full benefits of a main artery of commerce, the feeders must be carefully looked after. One of the greatest needs of Cuba to-day is a complete system of means of communication. It is recommended that, to secure the best results, all roads lying outside the limits of recorded repartos of the towns, or where such records (recorded repartos) do not exist, outside their built-up limits, should be in the care of the state, with a system of taxation for their construction and maintenance and proper regulations for their use and preservation. Owing to the prevailing bad roads, the freight traffic through the island, away from the railroads, not carried by pack animals, is hauled in huge carts drawn by oxen or mules.

Tire widths.—The cart wheels are about 6 feet in diameter, with comparatively narrow tires, and frequently with a play of several inches on the axles. When the cart bogs, a team is hitched to one wheel at a time, and the cart is thus worked out of the rut. This process simply makes a bad road worse. The weight of the cart and its con-

tents is frequently three tons and over, and the roads have to be very solidly constructed to resist them. This makes the cost of good roads in many parts of the island almost prohibitive. A good road law, which will establish a fixed relation between the weight borne and the width of tire, and which must be rigidly enforced, is essential. Such a law is being framed, based on road laws in the United States.

The allowed weight per square centimeter of contact of the wheel with the road surface for a vehicle without springs is fixed at 37.85 kilograms. The length of the wheel in contact on a hard road is assumed as 2.54 centimeters (1 inch). The total weight borne (including the weight of the vehicle) is limited to that obtained by multiplying this permitted weight by the width of the tire in centimeters; i. e., for a width of tire of 5 centimeters (approximately 2 inches) the weight allowed per wheel would be (37.85 by 2.54 by 5) 492 kilograms. When springs are used this weight is increased one-third. The weight of the vehicle being deducted, the weight of the allowed load is to be given in a certificate of registration and also painted on the side of the vehicle, together with the registration number.

Road construction.—In all of the sugar districts the soil is a rich, black loam, which packs very hard in dry weather, but which absorbs and holds water like a sponge. Careful drainage and a practically waterproof surface are essential in road construction in this soil. The drainage problem is difficult in many places, owing to flat grades. In such places it is necessary to provide a very heavy road covering. In the Porto Rico state roads through the cane lands the road metal, including foundation, is frequently from three-quarters to 1 meter in thickness. In Cuba good results are obtained by using a Telford foundation of large stones hand placed, from 8 to 12 inches deep, with a covering of from 4 to 6 inches of finer materials, all well rolled as placed. The metalled portion of the road is 5 meters (16.4 feet) wide, and the edge of the road metal is protected by a row of large stones, hand placed, with their tops flush with the road surface. The crowning is carried to the bottom of the ditch by a continuous curve, steeper on the sides of the ditch. Excepting where the depth of the ditch prevents, the entire surface is rolled from the bottom of the ditch on one side to the bottom of the ditch on the other. Thoroughly good road metal is difficult to obtain, excepting near Santiago, Cienfuegos and a few other points. The ordinary limestone rock answers well for the foundation. It has sufficient strength to resist crushing, but not to stand the abrasion of the wheels. The hard limestone found near Habana gives good results on the highways, but will not stand the concentrated street traffic of Habana, as discussed elsewhere in this report.

Bridges.—The bridge problem of the island is also difficult. Iron and steel corrode very rapidly, have a high first cost, and demand constant attention. In railway bridges in the neighborhood of Habana the influence of the prevailing winds is clearly shown in the increased corrosion on the sides of the bridge metal opposed to them. It is my opinion, based on experience to date, that for cheap construction the native hard-wood timber, with pile or preferably masonry piers, should be used, and for more permanent work stone, or a combination of brick or stone and concrete and iron or steel embedded in concrete. The absence of frost makes masonry of all kinds much more durable here than farther north. The rivers are subject to extremely

rapid fluctuations of level and have in a marked degree the characteristics of streams subject to floods flowing through alluvial soils, with the low water and extreme high-water banks well defined. Many failures of bridges have taken place in the past by the cutting out of the piers, and in bridge designs those conditions must be provided for.

Railway laws.—The laws governing concessions for railways and street railways are defective, cumbersome, and obstructive, and require revision and simplification. The intervention of provincial authorities should be abolished. For the lines of general communication the municipal intervention should be limited to a proper regulation for the portions lying within their built-up limits. For railways lying wholly within a municipality the State should have a general veto power, but should have no initiative.

Municipal works.—The urgent need of sewer systems, systems of water supply and distribution, and of sanitary pavements for the larger cities of the island calls for immediate expenditures which can not be met from the regular income. Provision should be made for raising money for these works by an authorized increase of the bonded indebtedness of the various cities, with such provision for payment as will relieve the rural portions of the municipalities of the cost of the urban improvements. The private ownership of city water-supply systems has proved inimical to the public interests in so many cases that it should be forbidden for the future. Cities should own supply and distribution systems and water should be sold by meter.

Concessions.—The entire subject of concessions for public or semi-public works in Cuba is very important, and in this respect Cuba is now comparable to the condition of the Old World a century ago, when monopolies were granted to and held by private parties, for considerations which bore little or no relation to the public good. Under the provisions of the Foraker law no new concessions have been granted since the American occupation. This law has been of great service to Cuba, but it is questionable whether the time has not come for its modification or abolition. Some provision should also be made for the abolition of many existing concessions which are now oppressive monopolies, and for a proper reimbursement to their owners, to be fixed by judicial action.

The "right of tanteo" as given in certain cases by existing law should also be abolished. Under this right if an individual presented a project for any public work to the government, having previously obtained permission to do so, and that project was accepted, when proposals for the contract for the work were called for if the individual who had presented the accepted project proved not to be the lowest bidder, he had a right within one-half hour after the proposals were opened to accept for himself the terms offered by the lowest bidder, and the contract had to be awarded to him. It is easy to see the abuses to which this practice is open, one of which is that there is absolutely no inducement offered to any other would-be contractor to make the expenditures necessary to gain the knowledge essential to permit him to make a low bid on an important work. Inasmuch as previous permission is necessary before the project is submitted, room is afforded for favoritism to the person to whom it may be desired to grant the right of tanteo.

Under the laws of Cuba the right of garnishment exists against public funds in the hands of disbursing officers. This right is denied

in the United States, as fixed by numerous judicial proceedings. As stated in Winthrop's Military Law, pages 1390, 1391:

Money in the hands of a disbursing officer for disbursement remains public funds till actually paid over to the person or persons entitled to receive it as due them. To allow it to be attached would be to divert the moneys of the United States from the specific purposes for which they have been appropriated by act of Congress, and, while a violation of law, would also seriously embarrass, and so far suspend, the operations of the Government. A government can not properly be placed in the position of a stakeholder between parties to whom it owes money and their assignees or creditors.

This quotation expresses good law and practice in the United States, and the same principle should be sound for Cuba. In practice in the United States it has always been possible for me to insure the payment of just debts by employees, and the laws protect by suitable provisions creditors of contractors. The same procedure here is strongly recommended.

City of Habana.—At this date the principal streets in Habana are in fair condition, considering the quality of pavement available. The old stone block pavement is slippery, badly worn, and has an irregular surface. After heavy rains holes are formed by the softened earth on which the stones are placed working up between them.

The quality of the stone used in the macadam work has been constantly improved as new quarries were found, and the cost of the broken stone has been reduced. In the first macadam renewals made last year the cost of the stone was excessive, and the only stone obtainable was of extremely poor quality. During the year, however, the demand for stone has caused the opening of new quarries and the installation of several stone-crushing plants, and competition has brought about a reduction in price. A further reduction in the cost of broken stone will be made when the new government quarry is in full operation. The stone from this quarry will suffice for renewals, and it is hoped that before much more extensive macadam work must be undertaken it will be possible to obtain a still better class of stone at reasonable rates.

In considering the work of the department on macadam streets the following conditions must be borne in mind:

First. The amount of money available for this work, month by month, was limited.

Second. A very large aggregate street area had to be given a smooth surface in as short a time as practicable, in order that the streets might drain themselves and might be kept clean.

Under these conditions it was necessary to use a stone the first cost of which should be as low as practicable and which could be procured in large quantities.

Early in last year an effort was made to obtain stone from the States, after advertisement, but the price bid was too high. Careful measurements are being made with experimental samples of high-priced stone on hand to determine the relative wear, in order that in new macadam work a stone may be used which at the end of a series of years will be most economical, taking into consideration first cost and cost of repairs. In the narrow streets of this city, where the traffic is very great and where the load is borne by two wheels with narrow tires, it is unreasonable to expect any macadam to be an economical pavement. Even asphalt block of the best quality has been worn down as much as 2½ inches in ten months at one point under concentrated traffic. The tables printed with the report on street repairs show the

general character of the traffic. In the macadamized part of the Calzada del Cerro the two street-car tracks in the middle of the street practically confine the ordinary wagon traffic to a narrow roadway, at places not over 3 meters wide, on either side of the track. The number of vehicles passing a given point between 6 in the morning and 6 in the evening, on a given day, was 1,752 by actual count, and on this thoroughfare the traffic continues all night.

On Corrales street, which has a width of $4\frac{1}{2}$ meters between curbs, and on which vehicles are permitted to pass in one direction only, 1,117 wagons passed on a given day between 6 a. m. and 6 p. m.

Under these circumstances the macadam streets have required constant repair, and the best class of macadam must always be the most expensive class of pavement when the cost of renewals is considered. The low unit cost of the work of the year is very gratifying.

It has been evident to everyone that modern smooth pavements are required throughout that portion of the city lying to the east of Belascoain and on the Calzadas and main thoroughfares in the suburbs. These pavements will have to be placed on a solid foundation of greater or less thickness, according to the nature of the traffic and the nature of the subsoil. In every case, for sanitary reasons, it will be desirable to have an impervious layer of mortar or concrete over the old street soil.

Attention is invited to the report of the interesting tests made of the brick, sheet asphalt, and asphalt block pavements. The data obtained is sufficient to show that these three forms of pavement, with proper foundation, will meet all the needs of Habana on streets where it is not practicable to use macadam. The block asphalt and the sheet asphalt can be used advantageously where the traffic is not concentrated too greatly and where it is unnecessary for the heavy carts to stand continuously while receiving and discharging their loads. In the narrow streets of the warehouse districts and in the streets on which the traffic is concentrated on narrow lines, the use of the best quality of paving brick will be the most satisfactory.

Inasmuch as the installation of the new sewer system at an early date necessitates the breaking up of almost the entire street surface of the city, and, further, since in the narrow street the traffic is entirely stopped during the time in which street improvements are made, to the great loss of the merchants of the vicinity, it has not been deemed advisable to lay permanent pavements extensively at present, even though, on streets like O'Reilly and Obispo, the need of a proper pavement is very great. It is believed that the sanitary record of the city since January, 1900, fully justifies the policy of the department in the expenditures made for repairs during the past year, without considering the great advantages to traffic which have resulted from giving a smooth surface to the almost impassable streets which the Americans found here on their arrival.

The work of preparing a grade map for the city streets has gone forward steadily, and new pavements should not be laid until all the grades of the city have been adjusted. At this late date the proper grades can not be given in every case without causing undue loss to adjacent property owners, and the changes of grade will have to be made with great care and only to the extent absolutely required for proper surface drainage.

The existing street-railway system in Habana is extremely poor. The roadway is badly built; the rails are of improper form, and are a

decided obstruction and danger to vehicular traffic; the service is very slow, and the cars are of an antiquated pattern. All of the existing lines belong to the Urbano Railway Company, now consolidated in the Habana Electric Company. During the Spanish régime another concession for street railways in the city of Habana had been granted, and the Urbano Company had been authorized to change its motive power. This last company has been anxious to install a modern system of street railways over its existing lines, and over routes covered by its concessions.

When these companies applied for authority to begin the work of construction and reconstruction it was seen that the construction of the lines as granted would leave large portions of Habana practically unprovided with railway facilities and would cause a complete obstruction of many of the important business streets in the city, as well as the destruction of the Prado as a pleasure drive and place of assemblage for the people—a matter of very great importance to the people of Habana. Under these circumstances, the two companies were informed that before work could be begun it would be necessary to devise a system of lines which would complement each other and give adequate facilities to all of Habana, with a minimum obstruction of the business streets. This was promptly acceded to by the companies, it being recognized by all concerned that in the matter of street-railway service the interests of the company and the interests of the city were practically identical, that system which would serve the greatest number of people best being also that which would produce the greatest revenue for the company; and, further, that a narrow street partially occupied by a rapid-transit railway would be practically closed to business traffic with ordinary vehicles, and that street crossings in the narrow streets would be extremely dangerous.

A plan was devised after many conferences between the representatives of the companies, of the city, and of the State, and the routes were changed, within the authority granted by existing laws, so that a system was formed which it is believed will best serve the interests of Habana for many years. The rails will be of the type used in Washington, D. C., with the top surface flush with the street pavement, laid on metal ties, and bedded in concrete. Electric traction will be employed, with a double overhead trolley, auxiliary feed wires being carried in conduits beneath the street. The use of the single overhead trolley and of dynamos having connection with the earth is prohibited. The routes are laid out in such a manner as to call for a minimum amount of curves and intersections, which, with the guards required at such points for the grooved rail, are always a great obstruction to the streets.

Two ducts in the conduits are reserved for the use of the State and city. The cars are to be of the most modern type, with cross seats, end entrances, and central aisles.

The double overhead trolley was authorized because it is believed to be impracticable to use an underground trolley in Habana, on account of the extremely heavy rainfall from time to time and the difficulty of disposing of storm water with sufficient rapidity.

The entire installation is to be of the best type. The project meets with the approval of the two companies—which are now consolidated—of the citizens and of the authorities, and active work of construction has been started.

In this connection attention is invited to the fact that, although

street excavations and street improvements have been made continuously during the last year, no cases of illness whatever could at any time be traced to this work. This experience is directly contrary to the opinion, so widely entertained, that in tropical and semitropical climates the turning up of the ground must be prohibited during the summer months. It is reasonable to believe that there must be some foundation for this opinion, and if so, the sanitary precautions taken by this department in carrying on work through the summer should receive the credit for this immunity from sickness. All earth taken out from the street and all surfaces exposed were thoroughly sprayed with electrozone or with a solution of chloride of lime. Wherever the materials removed appeared to contain organic matter, or to have been contaminated by sewage, these materials were in addition treated with quicklime, and were taken away from the street before nightfall.

The report of the department of street cleaning speaks for itself. The work has been thoroughly done at a very low cost, and the testimony of those who have visited Habana during the past winter is that Habana is now one of the cleanest cities in the Western Continent. It has been a matter of pride to the department of street cleaning and its efficient head to have the back streets and lanes kept as clean as the more conspicuous thoroughfares. The collection of refuse from the houses has been thoroughly systematized, and it is very rare that any complaint now is received of faults in this service.

Although the expense of such collection has been reduced, it is yet very high on account of the extremely long haul necessary to reach the crematory and the dump. This cost may be reduced very materially by establishing at least two more crematories for the service of the suburbs.

The cost of garbage disposal is also unsatisfactorily high, although the figures compare quite favorably with similar work elsewhere.

The Davis Crematory, erected last year, has proven to be odorless and practically smokeless. Entire carcasses of cattle and mules are consumed almost daily without trouble. The fireproof lining, however, was entirely too light, and has had to be renewed from time to time at great expense, and on account of the great demand for fire brick in the States it has been so far impossible to obtain a sufficiently durable fire brick for this work. A marked economy in the consumption of coal has been obtained by increasing the height of the stacks of the furnaces.

Taking the average for the past year, including repairs, with 1 ton of coal to each 12 tons of garbage, the average cost of coal per ton of garbage cremated has been 36.3 cents; the cost of labor and superintendence 79.7 cents. The cost of labor would have been reduced at least one-third had it not been for the incessant repair required. The recent increase of height of the stack has reduced the amount of coal consumed per ton of garbage by one-half. Coal is not used excepting when large carcasses have to be cremated.

The crematory is only used for such materials as would be liable to float when dumped into the sea, and eventually cause trouble by reaching the shore, and for materials in advanced stage of decay.

Experiments are being made for washing the loads from the garbage scows by means of a pump. When the apparatus is perfected the cost of dumping will be reduced, although it is believed the figures will not be as low as could be obtained by the use of proper self-dumping scows. These have not been bought because of lack of funds.

The parks of the city generally now present a fine appearance. Areas have been sodded successfully, with the result of economy in maintenance of the parks and increase of beauty. The improvement of the parks and the preservation of order by the park guard has caused them to be resorted to by women and children to a very much greater extent than ever before. This improvement is going steadily on as funds become available.

In the water department the work of the past year has resulted in great improvement to the service, with increased pressure throughout the city. The water wasted is still excessive, and can only be checked by the installation of the meter system.

For some months a new water ordinance has been in course of preparation, but the very heavy duties imposed upon the engineer department have delayed its completion. Authority has recently been granted for the construction of a pumping station close to the reservoir, to take the place of the temporary pumping station installed by the quartermaster's department for the service of the various posts on high ground in the vicinity of the city. The new station will have power enough to provide for a high service for the higher portions of the city, now without Vento water.

The extension of the water service to Casa Blanca, Luyano, and Regla is of marked benefit. The minor improvements at the Vento Springs have increased the flow from the Vento Aqueduct to its maximum capacity. This aqueduct is now in excellent shape, having been examined throughout its entire length and minor repairs having been made. The aqueduct is of insufficient capacity to do more than to supply the water used and wasted in Habana to-day. It can not supply the water that will be required in the near future for manufacturing purposes. At some time a new main must be laid from Vento to the reservoir, both for the additional water required and to furnish a duplicate main in case of accident to the aqueduct.

For manufacturing purposes a better use should be made of the old Zanja Real. It is believed that this aqueduct, which is now a source of loss to the city, and, on account of the unsanitary condition of its branches, a cause of illness, can be, for a small amount of money and with a thorough overhauling and regulating of the concessions granted and of misuse of the water, made a very important source of revenue to Habana.

The old aqueduct of Fernando VII can also be utilized to a greater extent than at present.

The main work of the sewer department during the past year has been in the preparation of plans for the sewer system of Habana. The conditions which must be met in providing a proper sewerage system for Habana are numerous. Sewage can not be emptied into the bay, nor can it be emptied off the coast at any point where it would be liable to be cast back on the shore near centers of population. The currents of the Gulf, within a mile of the shore line, are most variable, and the causes which produce these variations have not yet been discovered. The shore is of rock, and the depth increases so rapidly that the discharge must be made at a point quite close to the shore line. The streets of the city are very narrow, and it is difficult to see how room can be obtained for all of the underground constructions required in a modern city. These narrow streets will also cause the work of installation to be very difficult. Some of the trunk lines will have to be very long, with comparatively slight fall. Sewage from the low

land near the head of the bay will have to be raised by pumps in order to reach the seashore.

The rate of rainfall at times is very great. The accompanying chart of a typical city block shows how almost the entire space covered by the city is paved. This and the topography cause very large amounts of rain water to collect in the streets, which now follow valley lines, so that a depth of 2 feet with a very rapid current is sometimes found in the business streets.

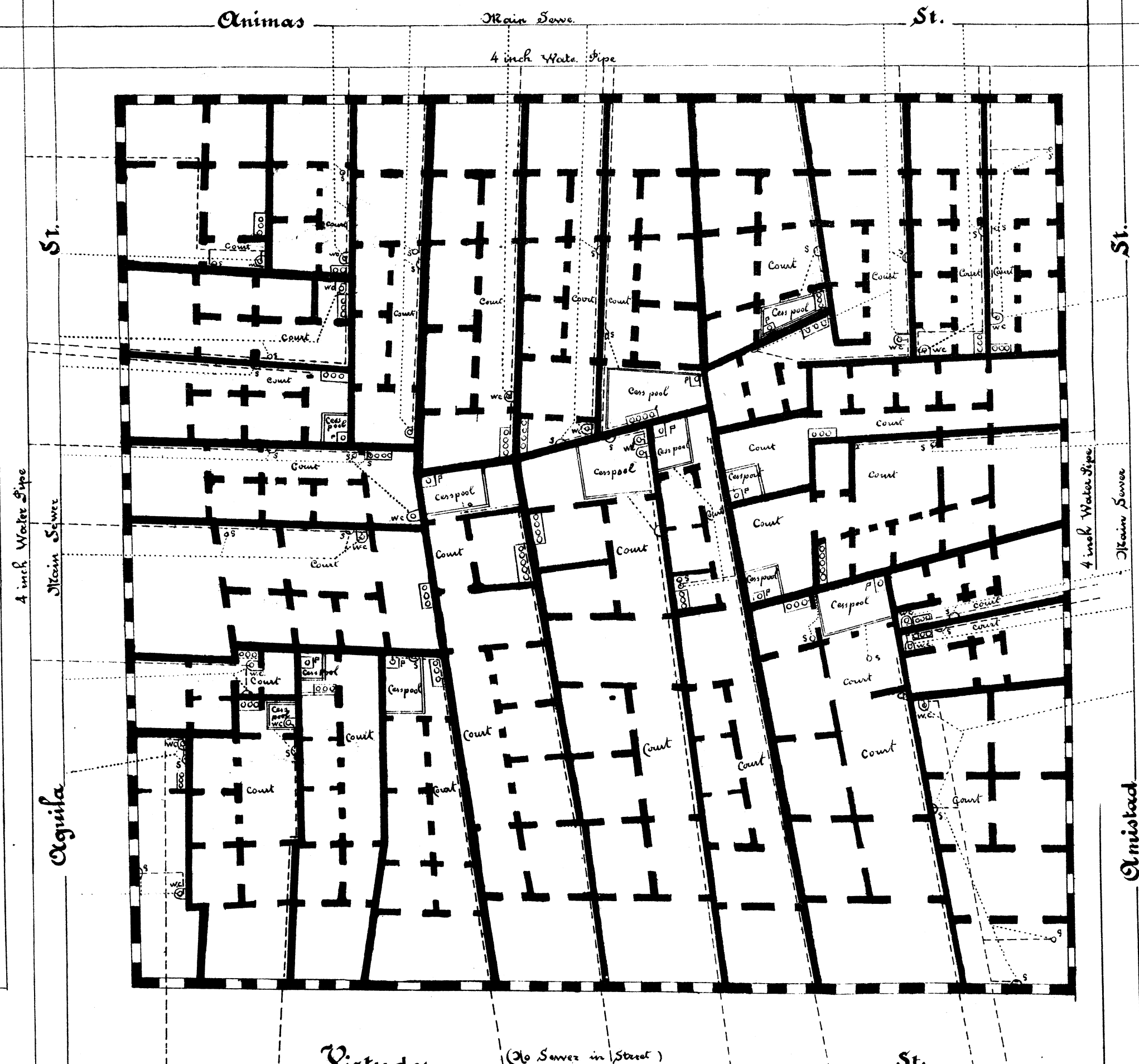
The formation of the harbor bottom is such as to present many difficulties for the construction of a sewer line across it. At the time of the American occupation there were practically no data available, except small-scale and somewhat inaccurate maps of the city, on which to base the calculations, with the exception of the very careful meteorological record which has been kept for many years by the Belen College authorities and which was most courteously placed at our disposal. It is therefore not to be wondered at that so much time has been necessary in the preparation of the sewer plans. The plans and estimates are now ready, and the work of construction can be started as soon as funds are available.

The project of Mr. M. J. Dady, which had been presented to the Spanish authorities and been under consideration by them since November, 1895, has been pressed from time to time upon the American authorities by its promoter. It is a matter of congratulation for the city of Habana that this project was never consummated.

The routine work of the sewer department has been to keep clean and free from obstruction the existing sewers and to disinfect them as far as practicable. A very important portion of the work of this department has been in connection with the insanitary plumbing in private houses. When the plumbing of a private house has been condemned by the sanitary officer and ordered removed, the plans for the new plumbing are prepared in this office. These plans are made such as to be adapted for present use and for future connection with the sewer system when established, at a minimum cost to the property owners.

The department also has charge of the operation of the electrozone plant. This plant was installed during the last fiscal year, it being deemed necessary to have facilities for providing a disinfectant of low cost, in as great quantities as could be required, without danger of the supply being cut off through possible commercial vicissitudes. Electrozone was chosen as being that which most nearly fulfilled these conditions. Laboratory tests as to the value of this disinfectant differ radically, and the opinions of laboratory sanitary experts are widely at variance with respect to its utility. It is believed, however, that the practical experience of the past year has proven beyond a doubt that electrozone has great value as a disinfectant. Late laboratory tests made by the Medical Department of the Army confirm this belief.

The work of extending the sewer near the Machina wharf, as described in the report of the works of the port, was believed to be so dangerous that it was undertaken only because the conditions were so extremely bad that it was thought to be less dangerous to remove them than to await the cold weather, and the work was carried on against the protest of physicians whose opinion carried weight. The work was accomplished successfully without one case of illness among

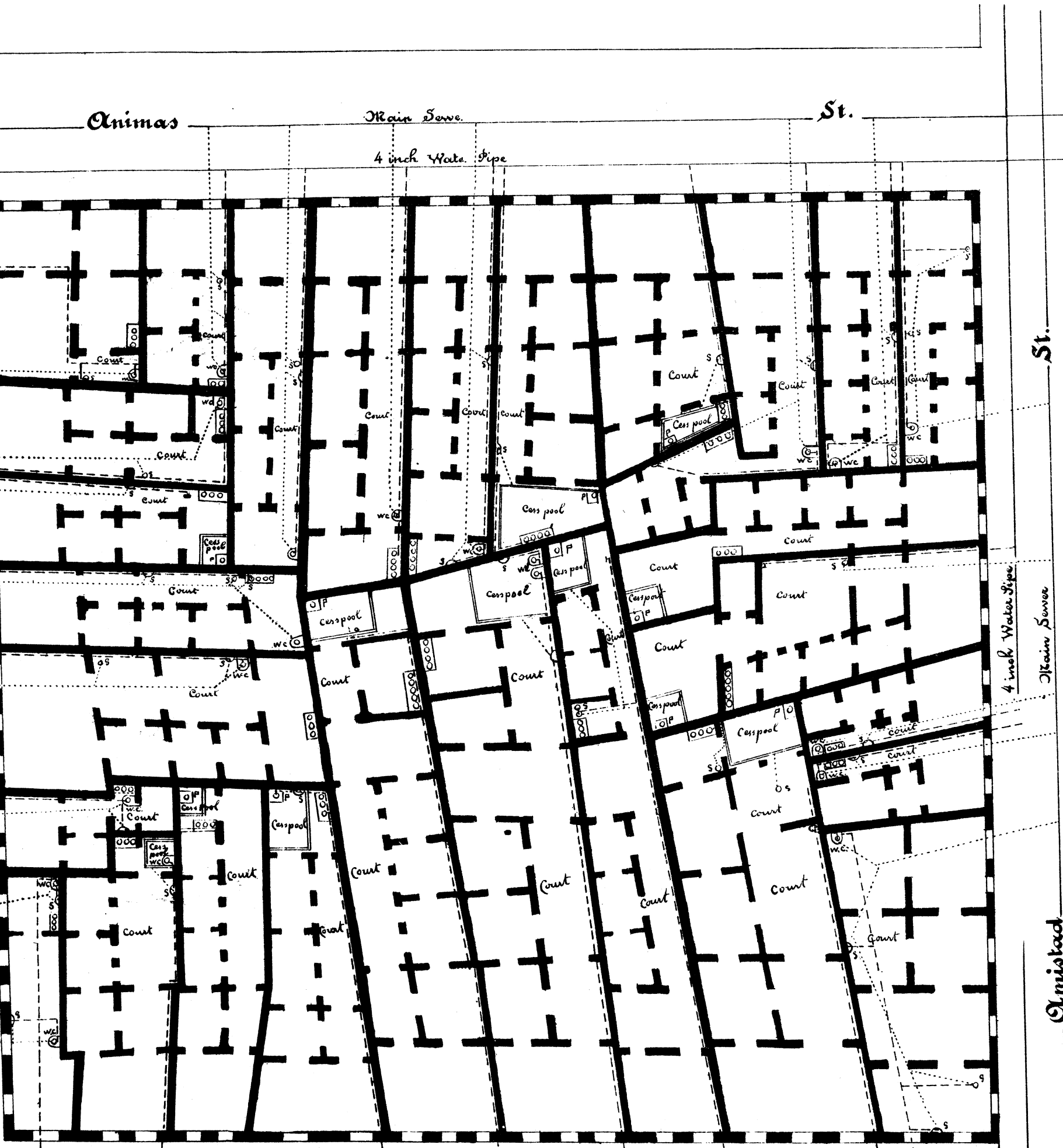


SKETCH OF Typical Residence IN Havana, C Scale, 1 equals 200

Note.

| | |
|------|-------------------------|
| --- | Indicates water service |
| --- | house drain |
| --- | cess pool not c |
| --- | water closet |
| W.C. | .. |
| S. | .. sink |
| P. | .. privy without |

Office of Chief E
Division of
To accompany Report of
M. M. Bla
Major Corps of Engin



SKETCH OF Typical Residential Block IN Havana, Cuba. Scale; 1 equals 200 meters.

Note.

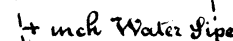
- Indicates water service pipe
- " house drain
- " cess pool not connected with sewer
- W.C. " water closet
- S. " sink
- P. " privy without water

Office of Chief Engineer.
Division of Cuba
To accompany Report of June 30th, 1900.
W. M. Black

Scale; 1 equals 200 m

| | | |
|-------|-----------|-------------------------|
| ----- | Indicates | water service pipe |
| | " | house drain |
| ===== | " | cess pool not connected |
| W.G. | " | water closet |
| S. | " | sink |
| P. | " | privy without water |

Major Corps of Engineers.
Chief Engineer. Division of

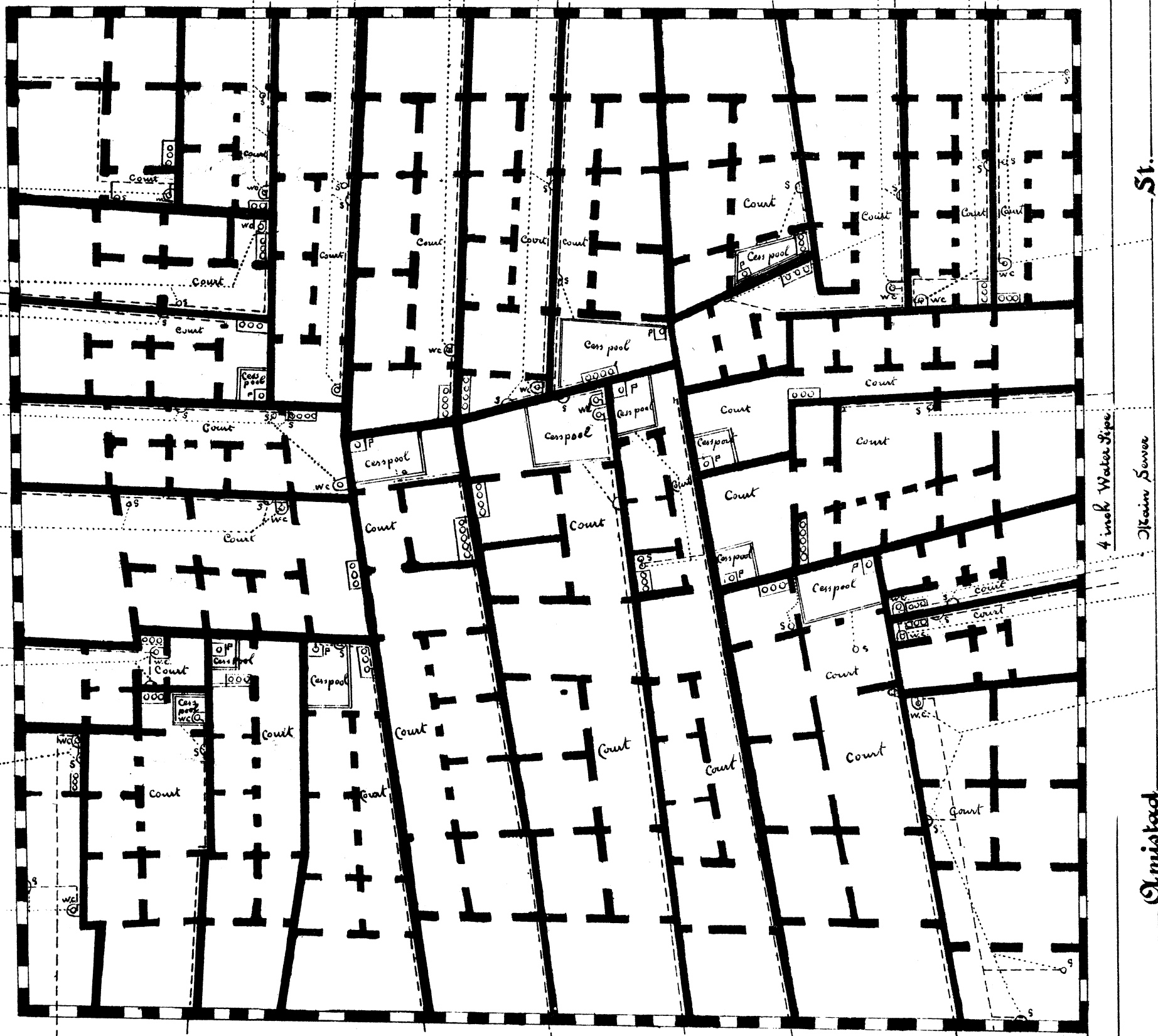


Animas

Drain Sewer

St.

4 inch Water Pipe



Virtudes

(No Sewer in Street)

4 inch Water Pipe

St.

St.

4 inch Water Pipe

Drain Sewer

Unistad

SKETCH

OF

Typical Residential Block

IN

Havana, Cuba.

Scale; 1 equals 200 meters.

Note.

- Indicates water service pipe
- " house drain
- " cess pool not connected with sewer
- W.C. " water closet
- S. " sink
- P. " privy without water

Office of Chief Engineer.

Division of Cuba

To accompany Report of June 30th, 1900.

W. M. Black

Major Corps of Engineers, U.S. Army.
Chief Engineer, Division of Cuba.

the employees, some of whom were nonimmune Americans, and without causing one case of illness in the neighborhood.

The work of reconstruction, renewal, and repair in the old post-office building, described in the report of the renovation of buildings, was also an extra hazardous risk. This work, too, was carried to completion during the hottest months of the year, without causing sickness among the workmen or among the employees of the signal service and cable office in the building while the work was carried on. These are only two examples of the many negative proofs which the experience of the year has given of the value of electrozone, and it can be seen that it would be very difficult to have positive proof in ordinary practice. It suffices to say that the general healthfulness of the city has been greatly improved and that there has been immunity from illness attending sanitary work in Habana, work of a nature considered hazardous and which some timorous souls desired to have suspended lest worse things might happen, but which necessity demanded should be done, and the credit for at least a portion of this immunity can be given to the use of this disinfectant. It is regretted that greater care was not taken to keep the output of the electrozone plant at full strength during the entire time. At least a portion of the product of the plant was not of full value. Fortunately no sickness resulted when the diluted electrozone was used. More uniform results are now being obtained, and it has been found that the addition of common salt to the sea water reduces the number of ampere hours required for the electricity to produce the requisite amount of electrolytic action.

In the progress of the work of the works of the port, native hardwood piles were found in the harbor, in excellent condition, which have been in place for nearly eighty years. Sea palm poles, known as "miraguanos," of the same age were also found to be perfect.

The relative value of yellow-pine creosoted lumber for wharf construction in Habana Harbor can now be tested, several piers supported on creosoted piles having been placed during the past year by other branches of the Government and by private parties.

The dredging plant has been kept fully occupied. Its usefulness would be very much increased by the purchase of additional scows and of another tug. There is enough work in the harbor to keep the entire plant with the required addition busy for many years.

The general cleanliness of the water in the harbor has been very markedly improved during the past year. This improvement is due to the cleaning of the streets and sewers, the partial disinfection of sewage, the constant removal of *débris* from the shores, and the vigilance of the harbor police in preventing ships from throwing rubbish overboard. Little or no work has been done toward redeeming the low land at the head of the harbor, and at low tide the flats near that point are very malodorous. When funds become available, the project long in existence for bulkheading the shores at the head of the bay, dredging the shoal water, and filling the low areas in the rear of the bulkhead with dredged material, covered with fresh earth, should be carried out. This would result in giving a greatly needed increased length of wharf line, in making very valuable additional areas of dry land, and, without doubt, in improving the general health of the population on the shores of the bay. It is believed, however, that the sanitary record of the past year has shown that the judgment formed at

the beginning of the year is correct, that the unhealthfulness of Habana arose far more from uncleanness in the city itself than from the harbor.

A very pressing need of Habana is additional wharf facilities for her commerce. The present system of landing merchandise from lighters causes a very great tax on the community, in increasing very markedly the cost of articles imported and exported.

The work of the renovation of buildings has been carried on in the most economical manner possible, as fully detailed in the report. The cost of all construction work here is markedly greater than the cost of similar work in the States. The general state of neglect in which all the public buildings were found and their extremely insanitary condition at the time of the American occupation rendered the amount of renovation necessarily very great.

The survey of the Department of Habana has made clear the unreliability of the published maps. The work of preparing accurate plans of the permanent fortifications, some of which are among the most interesting, elaborate fortifications of the old type now in existence, together with the contouring of the region around Habana, is now going on. This work should be extended, and, when possible, be made to cover the entire island.

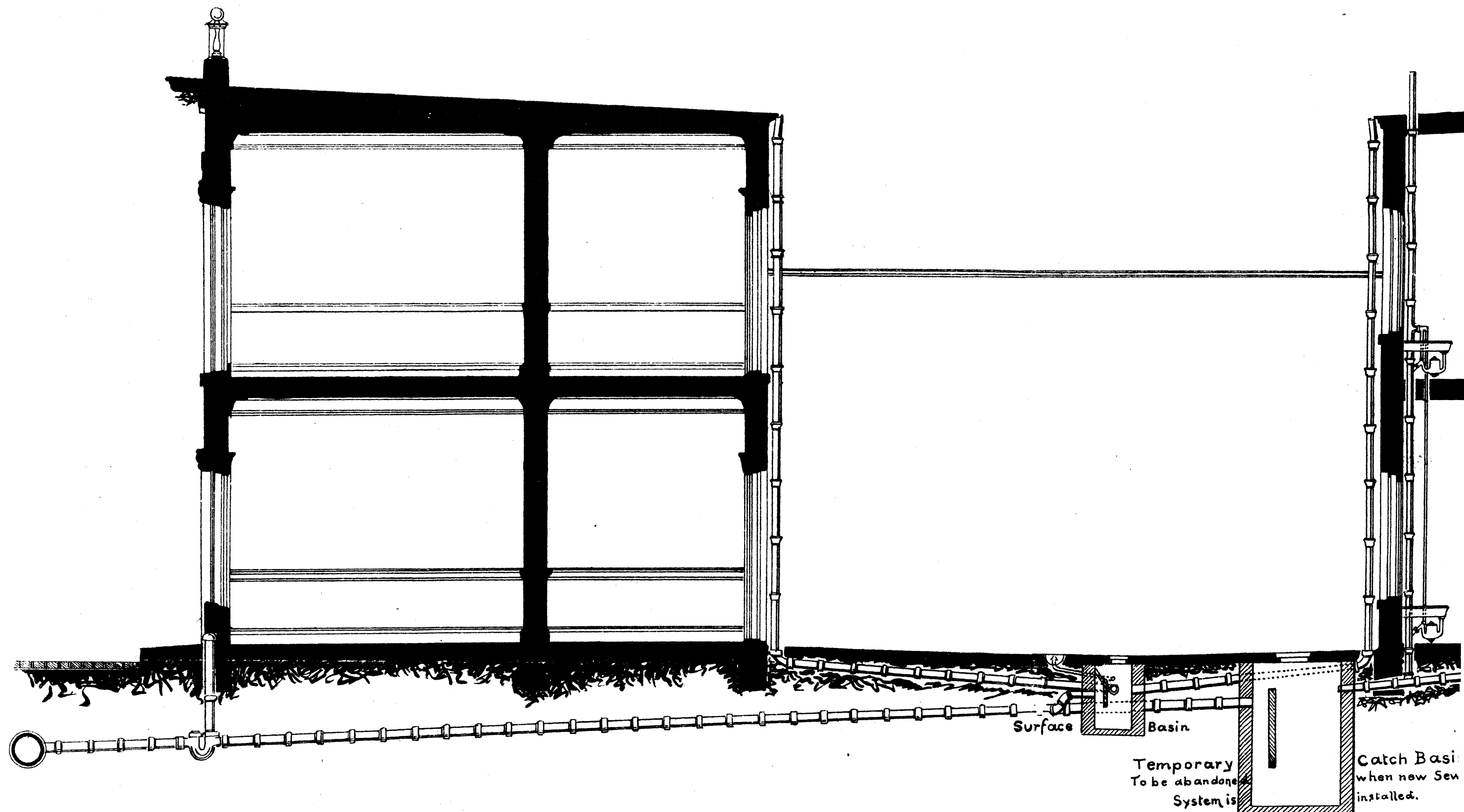
The existing status of the railway terminals in Habana is unsatisfactory and unsuited to the needs of a metropolis. All of the tracks are at street grade, and are sources of danger to the community, of inconvenience to street traffic, and of loss of time and money to the railways. Two of the three railway stations are inconveniently located, so that passengers using them have to take a long cab or car ride to pass between them and the heart of the city, consuming much valuable time and making it very inconvenient, if not impossible, for a business man to have a residence in one of the many beautifully located small towns within fifteen minutes ride of Habana. The Villanueva Station is excellently located, but very badly arranged. There is sufficient area in the train yard, which is rectangular in shape, but it lies with its greater length at right angles to the line of the road, so that to obtain the room in which to make up trains it has been necessary to deflect the track and to enter the yard at one corner on a curve, with a sharp curve within. An inspection of the city map will show how easy it would be, from an engineering standpoint, to provide all the space and obtain all the conditions necessary for a great modern terminus, by condemning and buying the six city blocks lying west of the north half of the yard, between it and Manrique street, selling the south half of the present yard, elevating the tracks and passing existing city streets beneath them. This should be done; the road should be elevated between the outskirts of the city and the station, and grade crossings abolished. All three railroads should be compelled to use the Villanueva Station for passenger traffic.

These improvements are of the class which are now being made in all great cities of the world, in most cases at enormous cost. They can be made now in Habana at comparatively slight cost, and should be made before the sure growth of the city increases this expense. According to modern practice the cost of changes of this character is divided between the railroad, the state, and the city. Provision should be made for it.

The objects for which large expenditures are required in the city of

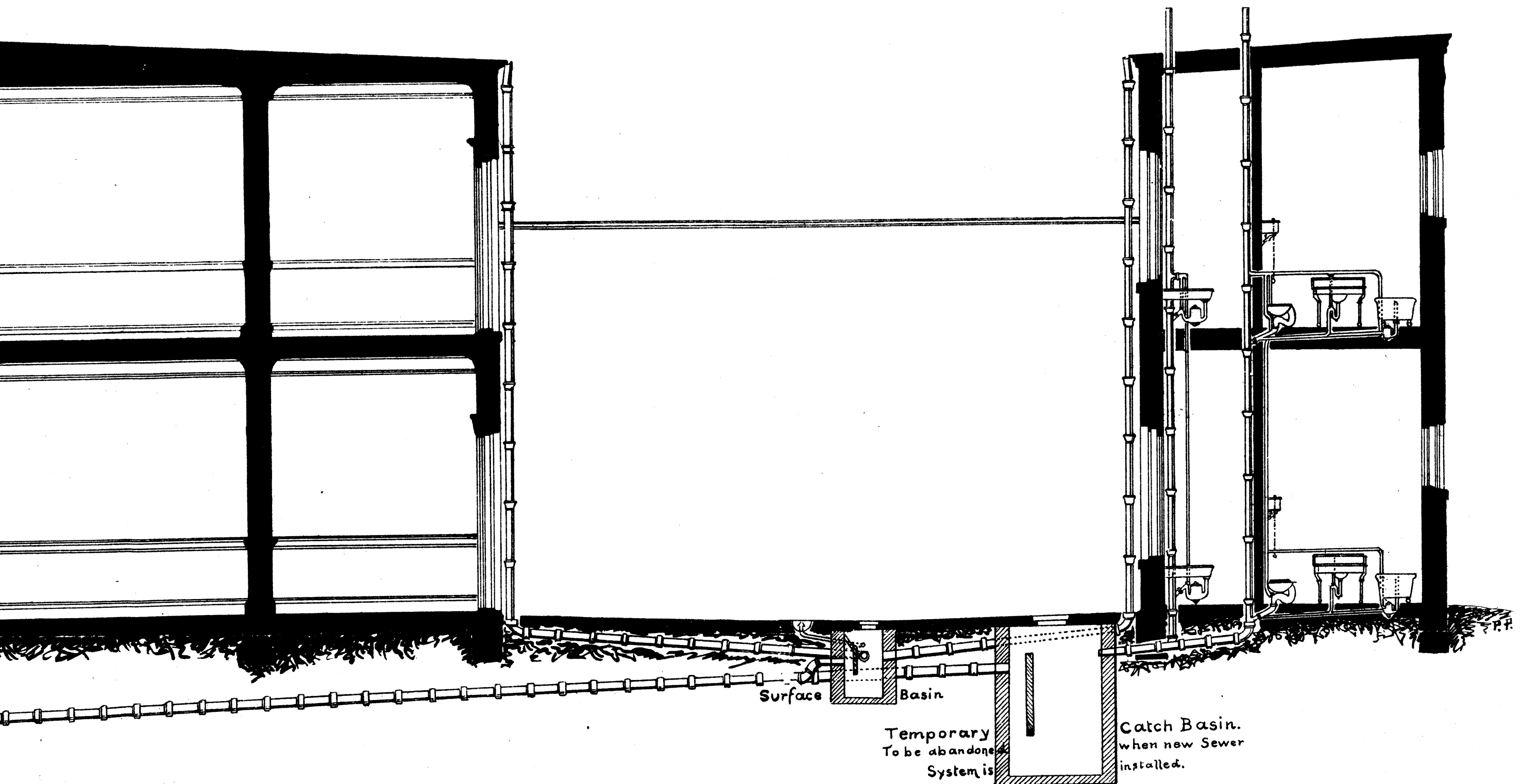
Office of Chief Engineer
City of Havana

PLAN FOR SANITARY PLUMBING AND HOUSE DRAINAGE



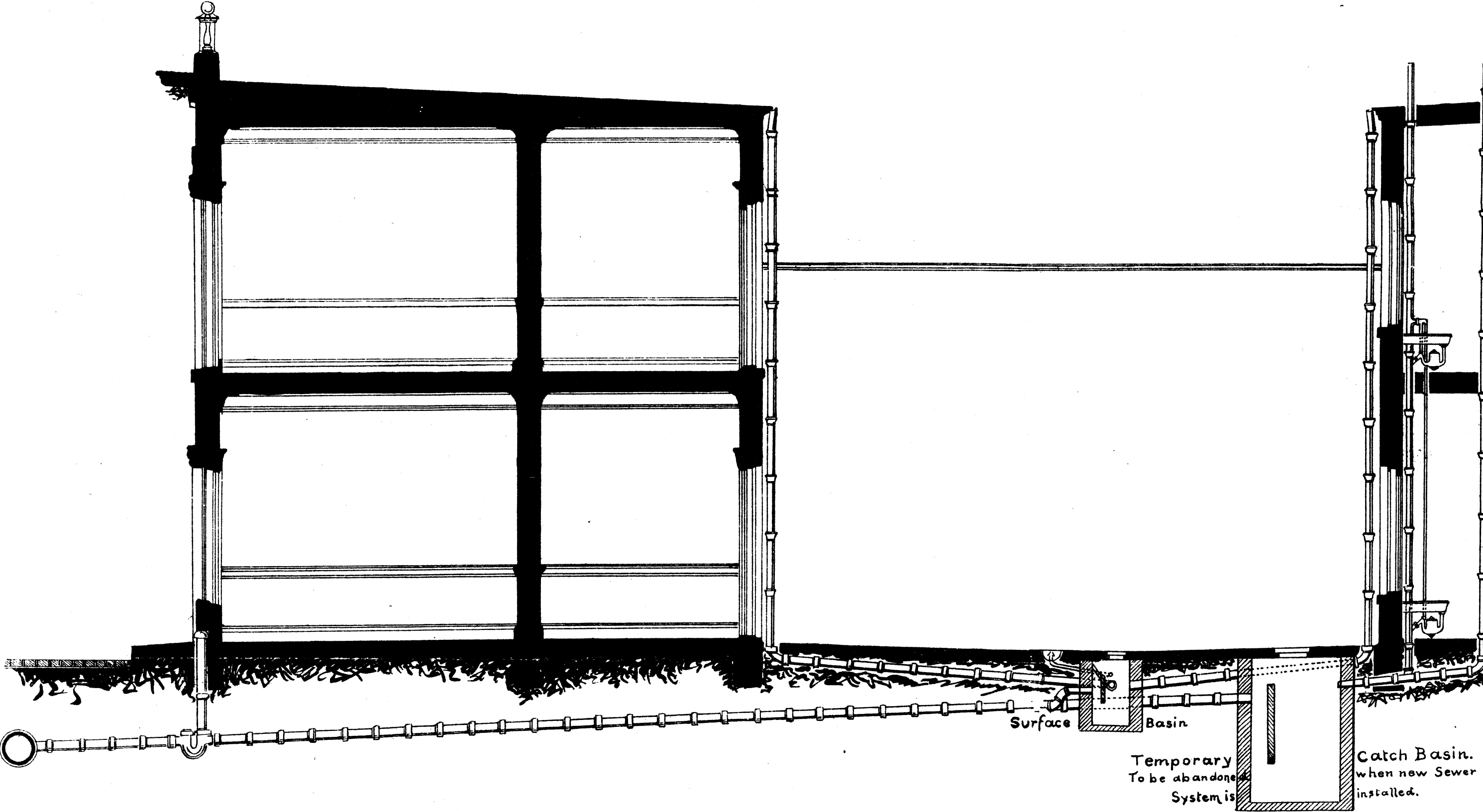
Office of Chief Engineer
City of Havana

PLAN FOR SANITARY PLUMBING AND HOUSE DRAINAGE

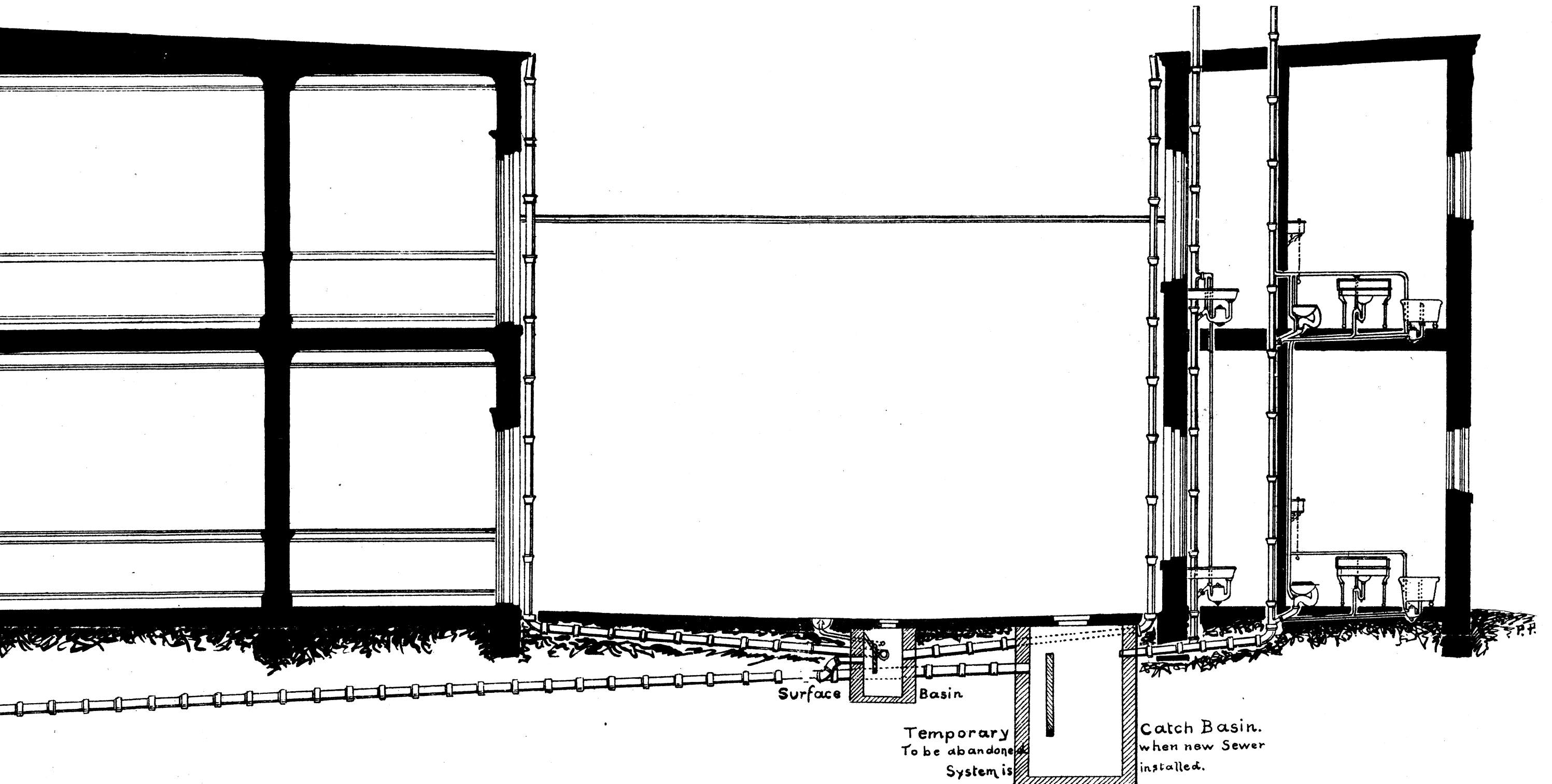


Office of Chief Engineer

PLAN FOR SANITARY PLUMBING
AND HOUSE DRAINAGE



PLAN FOR SANITARY PLUMBING AND HOUSE DRAINAGE



Office of Chief Engineer
Division of Cuba
To accompany report of June 30th 1900
W. H. Black
Major Corps of Engineers U. S. Army
Chief Engineer, Division of Cuba.

Habana, connected with the work of this department, may be summarized as follows: A new system of sewers, street pavements, subways of wires for the transmission of electricity, for light, power, telegraph, and telephone service, construction of force mains for water service for the high grounds of the city, construction of an additional main from the Vento Springs to the reservoirs, construction of a modern abattoir in a more suitable locality, and the destruction of the present slaughterhouse, extensive repairs to the city markets, purchase of proper dump scows for removal of refuse, the purchase of a tug and dump scows for dredged materials, the construction of shops with proper machinery for repairs to the city's plant, the construction of new piers, the regulation and improvement of the Zanja Real and branches, the bulkheading of the head of the bay, dredging of the head of the bay and filling of low ground, the formation of a public playground and park at and in the vicinity of Atares, the formation of a large park to include the public land of the Quinta de los Molinos, and in the vicinity of Principe Hill, the formation of a boulevard along the sea front, between the Punta and San Lazaro Hospital, the opening of new streets to connect the suburbs—Vedado, Cerro, and Jesus del Monte, the opening of streets parallel to Calzada del Cerro and to Calzada de Jesus del Monte, the abolition of steam railroad grade crossings within the city.

ENGINEER DEPARTMENT, CITY OF HABANA.

One of the very important attainments of the past year is the formation of a modern department of municipal works, in full working order, with complete records. With the exception that all of the work connected with the financial portion of the water service is not now in this department, the city of Habana has to-day an organization up to requirements of modern cities.

In forming the personnel of the department preference has been given to Cubans seeking employment. The absolute lack of experience of the natives of this island in general in modern municipal work has made it necessary to employ Americans to a very great extent. It is believed, however, that this department has, at the expense of some money and a great deal of time, succeeded in placing in training a number of Cubans for advancement later to higher posts. It would have been possible to have made a better showing in cost had none, with but few exceptions, but Americans been employed in all positions above the grade of laborer, but it is not believed that that would have been the proper policy to be pursued. In the works promotions have been made from the lower grades to the higher, with excellent results throughout, and a number of excellent foremen and inspectors have been obtained thereby. As time passes and as Cubans of the requisite training and acquirements become available the number of Americans can be gradually decreased. To-day there are not in the island of Cuba engineers, architects, master mechanics, master workmen, stenographers, and typewriters in numbers sufficient to carry on the works that are required.

The employees of this department, both native and foreign, have shown a pride in their work, and a willingness to do, in season and out of season, and to take risks which were frequently as great as to those in the battlefield, which are worthy of all praise.

My thanks are especially due to Mr. P. D. Cunningham, chief engineer of the city, who has assisted me in all my duties, which embraced all possible classes of municipal work, even that of a quasi-legal character. My thanks are also due to the heads of departments, Messrs. Cooke, Weber, Huston, McDonald, Harper, Armitage, Sargent, B. Weber, Strong, and Gardner, and to the office force and assistants in general. Mr. Arozarena, the city architect, has shown himself entirely fearless in enforcing the city building regulations, and has done so in the face of an opposition of a kind that is rarely met with in American cities.

Very respectfully, your obedient servant,

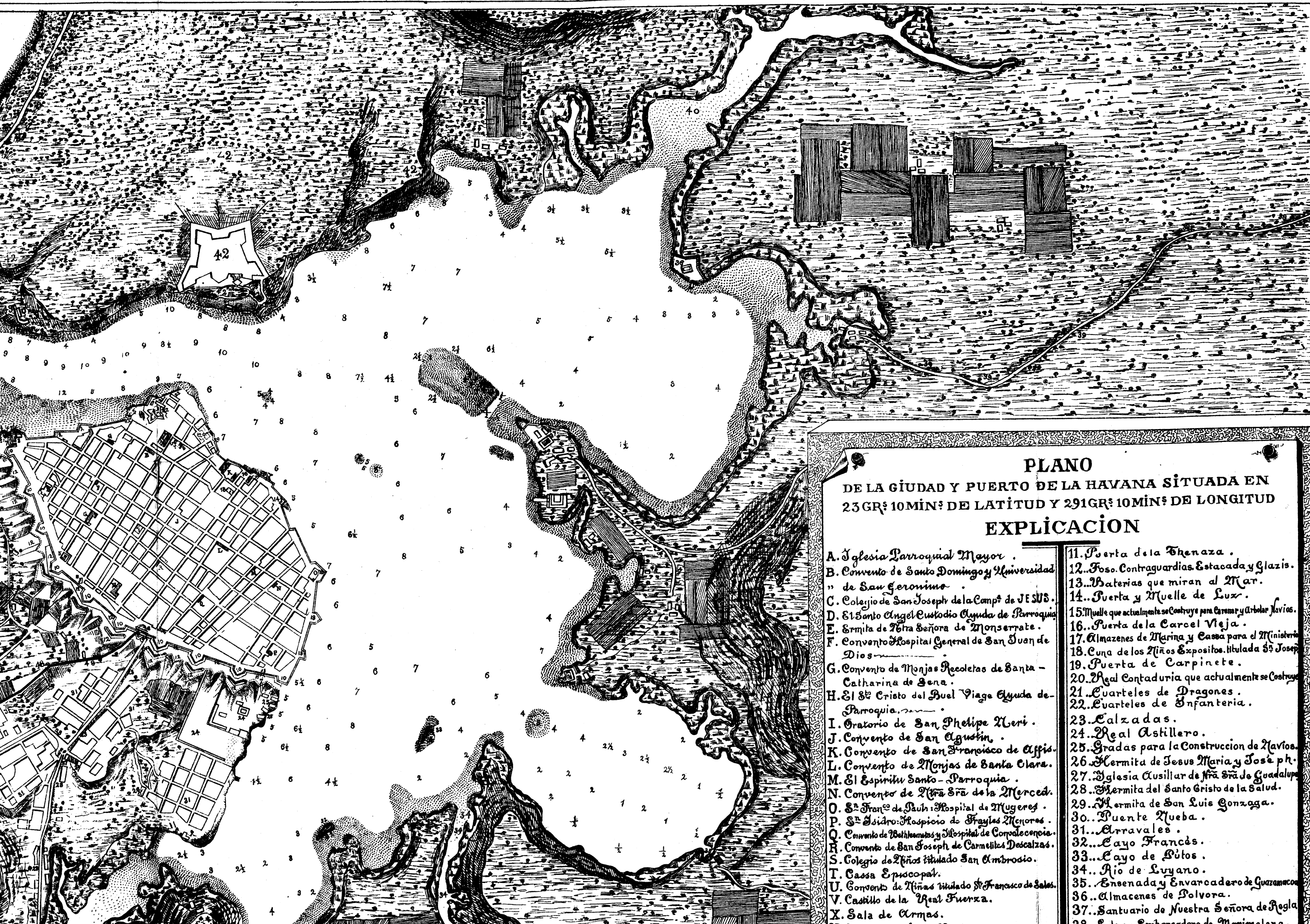
W. M. BLACK,
Major, Corps of Engineers, U. S. A.,
Chief Engineer, Division of Cuba.

The ADJUTANT-GENERAL, DIVISION OF CUBA.



DE LA CIUDAD Y PUERTO
23 GR: 10 MIN: DE LATITU
EXP

- A. Iglesia Parroquial Mayor .
- B. Convento de Santo Domingo y Univer
" de San Geronimo .
- C. Colegio de San Joseph de la Compt de JE
- D. El Santo Angel Custodio Ayuda de Pen
- E. Ermita de Nra Señora de Monserrati
- F. Convento Hospital General de San Juan
Dios .
- G. Convento de Monjas Recoletas de Santa
Catharina de Sena .
- H. El Sr Cristo del Buen Viage Ayuda
Parroquia .
- I. Oratorio de San Phelipe Neri
- J. Convento de San Agustin .
- K. Convento de San Francisco de A
- L. Convento de Monjas de Santa Ch
- M. El Espiritu Santo - Parroquia .
- N. Convento de Nra Sra de la Mer
- O. S^{ta} Fran^{ca} de Pau: Hospital de Mugere
- P. S^{ta} Isidro: Hospicio de Frayles Menor
- Q. Convento de Beateras y Hospital de Convaleci
- R. Convento de San Joseph de Carmelitas Desc
- S. Colegio de Niños titulado San Ambrosio
- T. Casa Episcopal.
- U. Convento de Ninas titulado St Francisco de
- V. Castillo de la Real Fuerza.
- X. Sala de Armas.
- Y. Bateria de Santa Barbara .



PLANO
DE LA GIUDAD Y PUERTO DE LA HAVANA SITUADA EN
23 GR^s 10 MIN^s DE LATITUD Y 291 GR^s 10 MIN^s DE LONGITUD
EXPLICACION

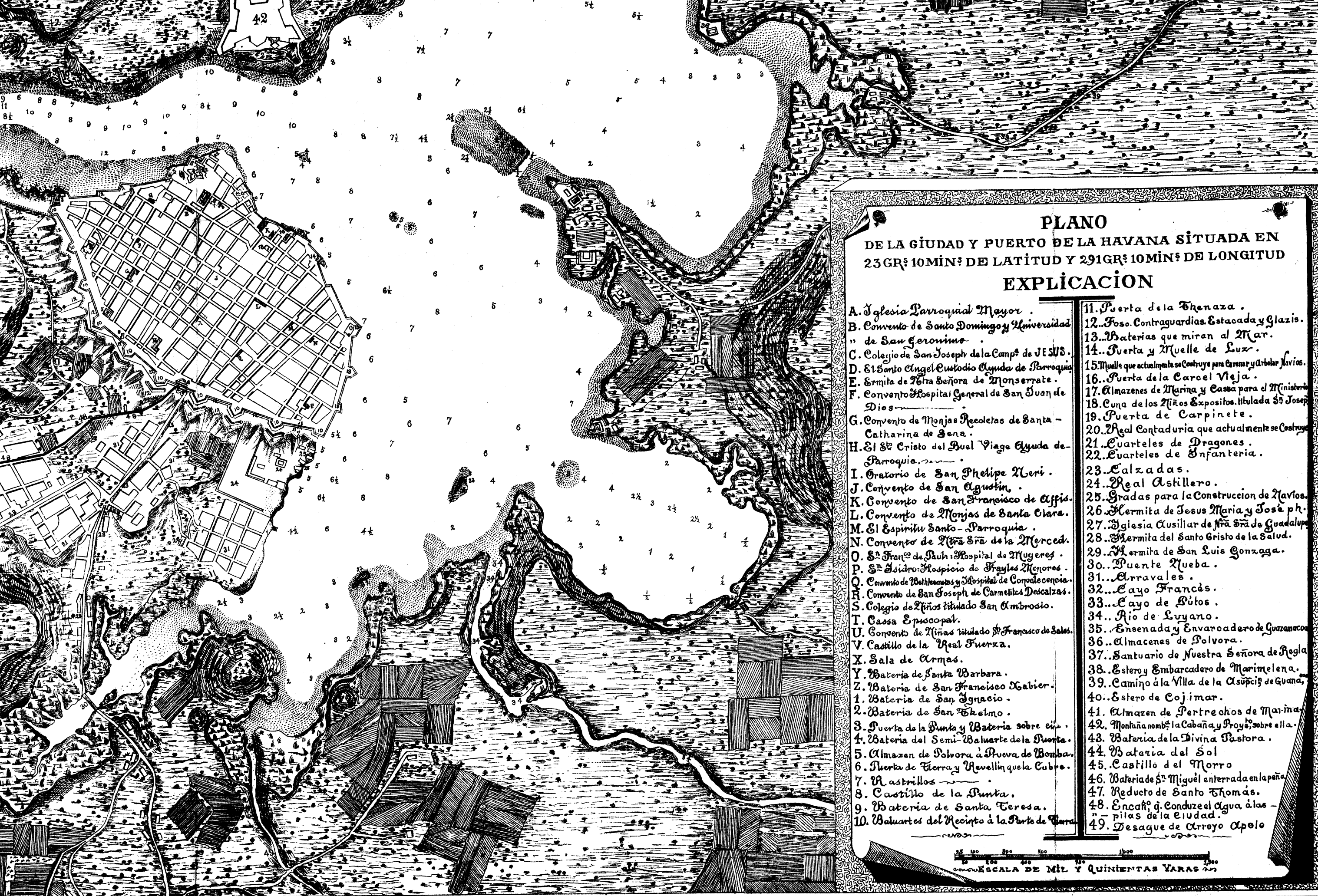
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|-------------------------------------------------------------------|---------------------------------------------------------------------|
| A. Iglesia Parroquial Mayor . | 11. Puerta de la Shenaza . |
| B. Convento de Santo Domingo y Universidad | 12..Foso. Contraguardias. Estacada y Glazis. |
| " de San Jeronimo . | 13..Baterias que miran al Mar. |
| C. Colegio de San Joseph de la Comp ^a de JESUS. | 14..Puerta y Muelle de Luz. |
| D. El Santo Angel Custodio Ayuda de Parroquia | 15.Muelle que actualmente se Construye para Cañon y Arbolar Navios. |
| E. Ermita de Nra Señora de Monserrate . | 16..Puerta de la Carcel Vieja . |
| F. Convento Hospital General de San Juan de Dios . | 17. Almacenes de Marina y Casa para el Ministerio |
| G. Convento de Monjas Recoletas de Santa - | 18. Cuna de los Niños Expositos. titulada S ^a Josep |
| Catharina de Sena . | 19. Puerta de Carpinete . |
| H. El S ^c Cristo del Buol Viage Ayuda de - | 20..Real Contaduria que actualmente se Construye |
| Parroquia . | 21. Cuarteles de Dragones . |
| I. Oratorio de San Phelipe Neri . | 22. Cuarteles de Infanteria . |
| J. Convento de San Agustin . | 23. Calzadas . |
| K. Convento de San Francisco de Asis . | 24..Real Astillero . |
| L. Convento de Monjas de Santa Clara . | 25. Gradas para la Construcion de Navios. |
| M. El Espiritu Santo - Parroquia . | 26. Hermita de Jesus Maria y Jose ph. |
| N. Convento de Nra S ^a de la Merced. | 27. Iglesia Auxiliar de Nra S ^a de Guadalupe |
| O. S ^c Fr ^{co} de Paul: Hospital de Mujeres . | 28..Hermita del Santo Cristo de la Salud. |
| P. S ^c Isidro: Hospicio de Frayles Menores . | 29. Hermita de San Luis Gonzaga . |
| Q. Convento de Bellesmues y Hospital de Conalecepcio. | 30..Puente Nueva . |
| R. Convento de San Joseph de Carmelitas Descalzas. | 31..Arravales . |
| S. Colegio de Niños titulado San Ambrosio . | 32..Cayo Francés . |
| T. Casa Episcopal . | 33..Cayo de Pulos . |
| U. Convento de Ninas titulado St Francisco de Sales. | 34..Rio de Luyano . |
| V. Castillo de la Real Fuerza . | 35. Ensenada y Envarcadero de Guazamacoa |
| X. Sala de Armas . | 36..Almacenes de Polvora . |
| | 37..Santuario de Nuestra Señora de Regla |
| | 38. S ^c Antonio de Guadalupe de Guadalupe |



PLA
DE LA GIUDAD Y PUERTO DE
23 GRº 10 MINº DE LATITUD Y
EXPLIC

- A. Iglesia Parroquial Mayor.
- B. Convento de Santo Domingo y Universidad
- de San Geronimo.
- C. Colegio de San Joseph de la Compª de JESUS.
- D. El Santo Angel Custodio Ayuda de Parroquia.
- E. Ermita de Nra Señora de Monserrate.
- F. Convento Hospital General de San Juan de Dios.
- G. Convento de Monjas Recoletas de Santa Catharina de Sena.
- H. El Stº Cristo del Buen Viage Ayuda de Parroquia.
- I. Oratorio de San Phelipe Neri.
- J. Convento de San Agustin.
- K. Convento de San Francisco de Alfis.
- L. Convento de Monjas de Santa Clara.
- M. El Espiritu Santo - Parroquia.
- N. Convento de Nra Sra de la Merced.
- O. Stº Fracº de Paul: Hospital de Mujeres.
- P. Stº Isidro: Hospicio de Frayles Menores.
- Q. Convento de Bellemas y Hospital de Convalecencia.
- R. Convento de San Joseph de Carmelitas Descalzas.
- S. Colegio de Niños titulado San Ambrosio.
- T. Casa Episcopal.
- U. Convento de Niñas titulado Stº Francisco de Sales.
- V. Castillo de la Real Fuerza.
- X. Sala de Armas.
- Y. Bateria de Santa Barbara.
- Z. Bateria de San Francisco Xavier.
- 1. Bateria de San Ignacio.
- 2. Bateria de San Telmo.
- 3. Puerta de la Punta y Bateria sobre ella.
- 4. Bateria del Semi-Baluarte de la Puerta.
- 5. Almazan de Polvora a Puerta de Bomba.
- 6. Puerta de Tierra y Revellin que la Cubre.
- 7. Astrillos.
- 8. Castillo de la Punta.
- 9. Bateria de Santa Teresa.
- 10. Baluartes del Recinto a la Puerta de Bomba.

ESCALA DE MILES



PLANO
DE LA CIUDAD Y PUERTO DE LA HAVANA SITUADA EN
23 GRº 10 MINº DE LATITUD Y 291 GRº 10 MINº DE LONGITUD
EXPLICACION

- A. Iglesia Parroquial Mayor .
B. Convento de Santo Domingo y Universidad
" de San Geronimo .
C. Colegio de San Joseph de la Compt de J. E. S. U. S.
D. El Santo Angel Custodio Ayuda de Parroquia
E. Ermita de Nra Señora de Monserrate .
F. Convento Hospital General de San Juan de
Dios .
G. Convento de Monjas Recoletas de Santa -
Catharina de Sena .
H. El Sr. Cristo del Buen Viage Ayuda de
Parroquia .
I. Oratorio de San Phelipe Neri .
J. Convento de San Agustin .
K. Convento de San Francisco de Affis-
L. Convento de Monjas de Santa Clara .
M. El Espiritu Santo - Parroquia .
N. Convento de Nra Sra de la Merced .
O. Sra. Franca de Pau: Hospital de Mujeres .
P. Sra. Isidro: Hospicio de Frayles Menores .
Q. Convento de Bethlehem y Hospital de Convalecencia .
R. Convento de San Joseph de Carmelitas Descalzas .
S. Colegio de Niños titulado San Ambrosio .
T. Casa Episcopal .
U. Convento de Ninas titulado St. Francisco de Sales .
V. Castillo de la Real Fuerza .
X. Sala de Armas .
Y. Bateria de Santa Barbara .
Z. Bateria de San Francisco Xavier .
1. Bateria de San Ignacio .
2. Bateria de San Telmo .
3. Puerta de la Punta y Bateria sobre ella .
4. Bateria del Semi-Baluarte de la Puerta .
5. Almacen de Polvora a Puerta de Bomba .
6. Puerta de Tierra y Revellin que la Cubre .
7. Astrillos .
8. Castillo de la Punta .
9. Bateria de Santa Teresa .
10. Baluartes del Recinto a la Puerta de Tierra .
11. Puerta de la Trenchaza .
12. Foso. Contraguardias. Estacada y Glazis .
13. Baterias que miran al Mar .
14. Puerta y Muelle de Luz .
15. Muelle que actualmente se Construye para Armar y Arbolar Navios .
16. Puerta de la Carcel Vieja .
17. Almacenes de Marina y Casa para el Ministerio .
18. Cuna de los Niños Expositos. titulada Sra. Josefa .
19. Puerta de Carpinete .
20. Real Contaduria que actualmente se Construye .
21. Cuarteles de Dragones .
22. Cuarteles de Infanteria .
23. Calzadas .
24. Real Astillero .
25. Gradas para la Construcion de Navios .
26. Ermita de Jesus Maria y Joseph .
27. Iglesia Auxiliar de Nra Sra de Guadalupe .
28. Ermita del Santo Cristo de la Salud .
29. Ermita de San Luis Gonzaga .
30. Puente Nueva .
31. Carravales .
32. Cayo Francés .
33. Cayo de Pitos .
34. Rio de Luyano .
35. Ensenada y Envarcadero de Guazamoc .
36. Almacenes de Polvora .
37. Santuario de Nuestra Señora de Regla .
38. Estero y Embarcadero de Marimelena .
39. Camino a la Villa de la Asuncion de Guanay .
40. Estero de Cojimar .
41. Almacen de Pertrechos de Marina .
42. Montaña nombrada la Cabaña y Proyo, sobre ella .
43. Bateria de la Divina Pastora .
44. Bateria del Sol .
45. Castillo del Morro .
46. Bateria de Sra. Miguel enterrada en la peña .
47. Reducto de Santo Thomas .
48. Encañ. q. Conduze el Agua a las
" pilas de la Ciudad .
49. Desague de Arroyo Apolo

ESCALA DE MIL Y QUINIENTAS VARAS

Traced in office of Water and Sewer Department.

JULIUS BIEN & CO PHOTO LITH.



PLANO

DE LA CIUDAD Y PUERTO DE LA HABANA, ESTENDIENDOSE AL O. MAS DE DOS LEGUAS; AL S. UNA Y MEDIA. Y AL E. CERCA DE UNA. DEDUCIDO DE VARIOS TRABAJOS
RECTIFICADO Y AUMENTADO EN EL AÑO 1830, DEDICADO AL EXCMO. SR. D. ANASTASIO DE ARANGO, DIRECTOR SUBINSPECTOR DEL REAL CUERPO DE INGENIEROS DE ESTA ISLA.

CALLES Y EDIFICIOS PUBLICOS DE INTRAMUROS.

- 1 Calle de Peña Pobre.
- 2 Callejón de la Leche.
- 3 Calle de los Cuarteles.
- 4 " de Chacón.

- 24 Calle de Acosta.
- 25 " de Jesús María.
- 26 " de la Merced.
- 27 " de Paula.
- 28 " de S. Isidro.
- 29 " Nueva de idem.

- 49 Calle de Villegas.
- 50 " Nueva del Cristo.
- 51 " de Curazao.
- 52 " de Bernaza.
- 53 " de Monserrate.
- 54 " de los Egidos.

COLEGIOS Y EDIFICIOS DE INSTRUCCION PUBLICA

- b, Colegio ó Seminario.—c, Univer-
sidad.—d, Colegio de niñas.—e, Aca-
demia de dibujo.

CALLES Y EDIFICIOS PUBLICOS DE EXTRAMUROS.

- 1 Calzada de S. Lázaro.
- 2 Calle de la Cárcel.
- 3 " de los Genios.
- 4 " de la Merced.

- 24 Calzada del Monte.
- 25 " del Horcón.
- 26 " de Jesús del Monte.
- 27 Calle de Vives.
- 28 " de Apodaca.
- 29 " de la Gloria.

- 49 Calle de S. Nicolás.
- 50 " de Manrique.
- 51 " del Campanario viejo.
- 52 " de la Perseverancia.
- 53 " de la Lealtad.
- 54 " de Escobar.

IGLESIAS

- A, Parroquia de Guadalupe.—B, Id.
de San Nicolás.—C, Idem de Jesús
María.—D, Id. del Pilar.—E, Id. del
Cerro.—F, Id. de Jesús del Monte.

TEATROS

Notas



PLANO

DE LA CIUDAD Y PUERTO DE LA HABANA, ESTENDIENDOSE AL O. MAS DE DOS LEGUAS; AL S. UNA Y MEDIA. Y AL E. CERCA DE UNA. DEDUCIDO DE VARIOS TRABAJOS RECTIFICADO Y AUMENTADO EN EL AÑO 1838, DEDICADO AL EXCMO. SR. D. ANASTASIO DE ARANGO, DIRECTOR SUBINSPECTOR DEL REAL CUERPO DE INGENIEROS DE ESTA ISLA.

CALLES Y EDIFICIOS PUBLICOS DE INTRAMUROS.

- 1 Calle de Peña Pobre.
- 2 Callejón de la Leche.
- 3 Calle de los Cuarteles.
- 4 " de Chacón.
- 5 " del Tejadillo.
- 6 " del Empedrado.
- 7 Callejón de San Juan de Dios.
- 8 " de la Bomba.
- 9 " del Chorro.
- 10 Calle de O'Reilly.
- 11 " del Obispo.
- 12 Callejón de Justiz.
- 13 Calle de la Obrapia.
- 14 " de la Lamparilla.
- 15 " de la Amargura.
- 16 " de Teniente Rey ó Sta. Teresa.
- 17 " de S. Salvador de Orta.
- 18 " de Rieña ó la Muralla.
- 19 " de la Cuna.
- 20 " del Sol.
- 21 Callejón de la Samaritana.
- 22 Calle cerrada de Sta. Clara.
- 23 " de Luz.

- 24 Calle de Acosta.
- 25 " de Jesus María.
- 26 " de la Merced.
- 27 " de Paula.
- 28 " de S. Isidro.
- 29 " Nueva de idem.
- 30 Callejón de la Artillería.
- 31 " de las Recogidas.
- 32 Calle de los Desamparados.
- 33 " de S. Pedro.
- 34 " del Baratillo.
- 35 " de Tacón.
- 36 " de los Oficios.
- 37 " de Mercaderes.
- 38 " del Inquisidor.
- 39 " de S. Ignacio.
- 40 " de Cuba.
- 41 " de Aguilar.
- 42 " de las Dumas.
- 43 " de Habana.
- 44 Callejón del Ajud.
- 45 Calle de Compostela.
- 46 " del Aguacate.
- 47 Callejones de Bayona.
- 48 Calle de la Picota.

- 49 Calle de Villegas.
- 50 " Nueva del Cristo.
- 51 " de Curazao.
- 52 " de Bernaza.
- 53 " de Monserrate.
- 54 " de los Egidos.

IGLESIAS.

A, Parroquia del Angel.—B, Catedral.—C, Convento de San Juan de Dios.—D, Monjas Catalinas.—E, Convento de Santo Domingo.—F, Convento de San Felipe.—G, Parroquia del Cristo.—H, Convento de San Agustín.—I, Monjas Teresas.—J, Convento de San Francisco.—K, Monjas Ursulinas.—L, Idem de Sta. Clara.—M, Convento de Belén.—N, Parroquia del Espíritu Santo.—O, Convento de la Merced.—P, Id. de San Isidro.

CUARTELES.

Q, de Santelmo.—R, de Milicias.—S, de la Fuerza.—T, de Santo Domingo.—V, de Belén.—X, de Artillería.

HOSPITALES.

Y, de San Juan de Dios.—Z, Militar de San Ambrosio.—a, de Paula para mujeres.

COLEGIOS Y EDIFICIOS DE INSTRUCCION PUBLICA

b, Colegio ó Seminario.—c, Universidad.—d, Colegio de niñas.—e, Academia de dibujo.

EDIFICIOS Y PARAJES PUBLICOS

f, Correo.—g, Intendencia.—h, Capitanía del puerto.—i, Casa de Gobierno y oficios públicos.—j, Plaza de Armas.—k, Consulado.—l, Obispaño.—m, Aduana.—n, Oficio de Comandancia de Marina.—o, Maquina.—p, Teatro.—q, Alameda de Paula.—r, Depósito Topográfico de Ingenieros.—s, Casa de Recogidas.

PUERTAS

t, de la Punta.—u, de Monserrate.—v, de los Vapores de Regla.—x, Para buques chatos de idem.—y, de Luz.—z, de Tierra.—aa, Nueva.—bb, de la Tenaza.

MERCADOS

cc, del Cristo.—dd, de Cristina.

CALLES Y EDIFICIOS PUBLICOS DE EXTRAMUROS.

- 1 Calzada de S. Lázaro.
- 2 Calle de la Cárcel.
- 3 " de los Genios.
- 4 " de la Merced.
- 5 " de las Canteras.
- 6 " del Trocadero.
- 7 " de las Animas.
- 8 " de las Virtudes.
- 9 " de la Concordia.
- 10 " de Neptuno.
- 11 " de Sta. Bárbara.
- 12 " de S. Miguel.
- 13 " de S. Rafael.
- 14 " de S. José.
- 15 " de Cristina.
- 16 Callejón del Cuchillo.
- 17 Calle de Dragones.
- 18 " Real de la Salud.
- 19 Calzada de S. Luis Gonzaga.
- 20 Calle de la Bstrella.
- 21 " de la Maloja.
- 22 " de los Sitios de S. José.
- 23 " de Peñalver.

- 24 Calzada del Monte.
- 25 " del Horcón.
- 26 " de Jesus del Monte.
- 27 Calle de Vives.
- 28 " de Apodaca.
- 29 " de la Gloria.
- 30 " de la Misión.
- 31 Callejón de S. José.
- 32 Calzada del Arsenal.
- 33 Calle de la Esperanza.
- 34 " de la Alcantarilla.
- 35 Calzada de Vives.
- 36 Calle de la Puerta Cerrada.
- 37 " de la Diaria.
- 38 " de Tallapiedra.
- 39 " del Morro.
- 40 " del Prado.
- 41 " del Consulado.
- 42 " de la Industria.
- 43 " de Crespo.
- 44 " de la Amistad.
- 45 " del Águila.
- 46 Calzada de Galiano.
- 47 Calle de los Angeles.
- 48 " del Rayo.

- 49 Calle de S. Nicolas.
- 50 " de Manrique.
- 51 " del Campanario viejo.
- 52 " de la Perseverancia.
- 53 " de la Lealtad.
- 54 " de Escobar.
- 55 " Cerrada del Paseo.
- 56 " de Gervasio.
- 57 Callejón de Chávez.
- 58 Calzada de la Beneficencia.
- 59 Calle de la Economía.
- 60 " Ancha.
- 61 " de Cienfuegos.
- 62 " de Someruelos.
- 63 " de Factoría.
- 64 " del Palomar ó de Suárez.
- 65 " Real de Jesus María.
- 66 " de la Florida.
- 67 " del India.
- 68 " de Peña Blanca.
- 69 " del Alambique.
- 70 " de Antón Moco.
- 71 " de la Cañada.
- 72 " de la Merced.
- 73 " del Cóngrero.

IGLESIAS

A, Parroquia de Guadalupe.—B, Id. de San Nicolás.—C, Idem de Jesús María.—D, Id. del Pilar.—E, Id. del Cerro.—F, Id. de Jesús del Monte.

TEATROS

G, de Tacón.—H, del Diorama.—I, de Jesús María.

CEMENTERIOS

J, General.—K, del Horcón.

CARCEL, CUARTELES Y OTROS

L, Cárcel, Cuarteles de infantería y Presidio.
M, Casa de Beneficencia.
N, Hospital de San Lázaro.
O, Casa de Dementes.
P, Id. de idem para mujeres.
Q, Colegio de San Fernando.
R, Cuartel de Dragones.
S, Plaza de mercado de Tacón.
T, Tallapiedra.
V, Depósito de Cimarrones.
X, Colegio de Carragano.

Notas

1.

Los números de la sonda indican pies de Burgos.

2.

El barrio de San Lázaro está comprendido entre la costa norte y la sanja real; el de Guadalupe entre éste y la Cahada del Monte, y el de Jesus María entre esta última y la costa de la bahía.

[illegible]

Nº 2.

N.º 3. - 1604

N.º 3. - 1604

N^o 1^o - 1604

Cueva
de Taganana.

Torreón
de la Calera.

Uveros

Mapa ilustrativo de la obra titulada
LO QUE FUIMOS Y LO QUE SOMOS
o la Habana antigua i moderna.
Construido por el autor de la misma
Dr. José M.^{te} de la Torre.
1857.

La Purisima

Estancia de D. Martín Oquendo.

Hand-drawn map of the Huerta de Borges area, showing various locations and distances. The map includes labels for 'Huerta de Borges', 'lugar de Arostegui', 'Jaspues de D. Laxaro', 'Charoz', 'Huerta de D. Gonzalez Borges', 'de D. Adrian J. de', 'Jaspues de los Barrios', 'Munay', 'lugar de Arostegui y de Pedrozu', 'Distancia de los Sigüeros despues de los Arostegui', and 'Molino de Borges despues del Rey (1796-1821)'. A scale bar at the bottom indicates '133' and '131'.

122
Huerta de D.
Buenaventura
Toldeo despues
de Morales.

121
Estancia del Oidor
D. D. Bernardo de
Urrutia y Matos
después de Garrini.

116
Estancia
de D.
Antonio
de Xayas
829p55r

Estancia de D. Cristobal de Salas
ingeniero
de la Real
1896

772 Estancia de
Gabriel Jose Co
2427 p 1/2 r

Estancia de
R^l Arsenal
en 1740

de Sat
E
pa
B

24
Estancia de D^a Rosalba
de Cordova de Sierra.

D Pedro Garcia
Monocal:

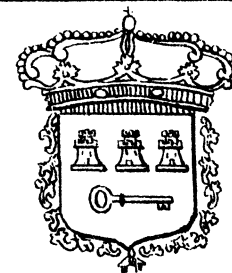
N°4-1604

N°4-1604

1° 1604



Mapa ilustrativo de la obra titulada
LO QUE FUIMOS Y LO QUE SOMOS
o la Habana antigua i moderna.
Construido por el autor de la misma
Dr. José M^{te} de la Torre.
1857.



Escudo de la Habana
según se ve en la antigua
Casa Capitular
hoy conocida por de Armona
(Plaza de S. Francisco)

131 Huerta de D. Nicotas
Gonzalez Borges luego
de D. Adrian J. de Armas
después de los Barreras.

122 Huerta de D.
Buenaventura
Tolado después
de Morales.

115 Estancia
de D. Pedro
de las Heras
después de los
Barreras
326 p² 3 r²

110 Estancia
de D. Titurcio
de la Barrera
379 p² 1/2 p²

121 Estancia del Oidor
D. D. Bernardo de
Urrutia y Matos
después de Garrini

116 Estancia
de D.
Antonio
de Xayas
829 p² 5/4 r²

119 Estancia
de D. Juan
de Dios
Monocal.

124 Estancia de D. Rosalía
de Cordova de Sierra.

D. Pedro Garcia
Monocal.

de Casa Bayona
luzado en 1736 de 186 p²

Estancia de D. Miguel
de Castro Palomino
D. M. Alvarez

108 Estancia de D.
Antonio de la Luz
1058 p² 6 r²

113 Estancia de D.
Francisco Flores
1322 p² 1/2 r²

Estancia de D. Esteban de Salas
1296 p² 2 r²

118 Estancia de D. Pío de Rivas
1220 p² 1/2 r²

120 Estancia de D. Pío de Rivas
1220 p² 1/2 r²

Estancia
107
del Castellano
D. José
de S. Cruz
326 p²

Estancia de
D. Miguel
de Castro Palomino
D. M. Alvarez

108 Estancia de D.
Antonio de la Luz
1058 p² 6 r²

113 Estancia de D.
Francisco Flores
1322 p² 1/2 r²

Estancia de D. Esteban de Salas
1296 p² 2 r²

118 Estancia de D. Pío de Rivas
1220 p² 1/2 r²

120 Estancia de D. Pío de Rivas
1220 p² 1/2 r²

Estancia
107
del Castellano
D. José
de S. Cruz
326 p²

Estancia de
D. Miguel
de Castro Palomino
D. M. Alvarez

108 Estancia de D.
Antonio de la Luz
1058 p² 6 r²

113 Estancia de D.
Francisco Flores
1322 p² 1/2 r²

Estancia de D. Esteban de Salas
1296 p² 2 r²

118 Estancia de D. Pío de Rivas
1220 p² 1/2 r²

120 Estancia de D. Pío de Rivas
1220 p² 1/2 r²

Estancia
107
del Castellano
D. José
de S. Cruz
326 p²

Estancia de
D. Miguel
de Castro Palomino
D. M. Alvarez

108 Estancia de D.
Antonio de la Luz
1058 p² 6 r²

113 Estancia de D.
Francisco Flores
1322 p² 1/2 r²

Estancia de D. Esteban de Salas
1296 p² 2 r²

118 Estancia de D. Pío de Rivas
1220 p² 1/2 r²

120 Estancia de D. Pío de Rivas
1220 p² 1/2 r²

Estancia
107
del Castellano
D. José
de S. Cruz
326 p²

Estancia de
D. Miguel
de Castro Palomino
D. M. Alvarez

108 Estancia de D.
Antonio de la Luz
1058 p² 6 r²

113 Estancia de D.
Francisco Flores
1322 p² 1/2 r²

Estancia de D. Esteban de Salas
1296 p² 2 r²

118 Estancia de D. Pío de Rivas
1220 p² 1/2 r²

120 Estancia de D. Pío de Rivas
1220 p² 1/2 r²

Estancia
107
del Castellano
D. José
de S. Cruz
326 p²

Estancia de
D. Miguel
de Castro Palomino
D. M. Alvarez

108 Estancia de D.
Antonio de la Luz
1058 p² 6 r²

113 Estancia de D.
Francisco Flores
1322 p² 1/2 r²

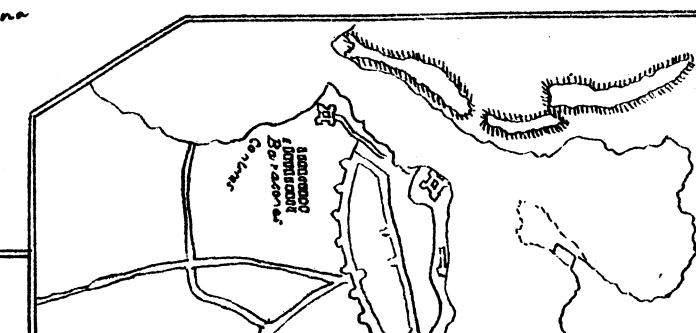
Estancia de D. Esteban de Salas
1296 p² 2 r²

118 Estancia de D. Pío de Rivas
1220 p² 1/2 r²

120 Estancia de D. Pío de Rivas
1220 p² 1/2 r²

Las manzanas de línea,
han sido las primera-
mente pobladas.

N° 4-1604

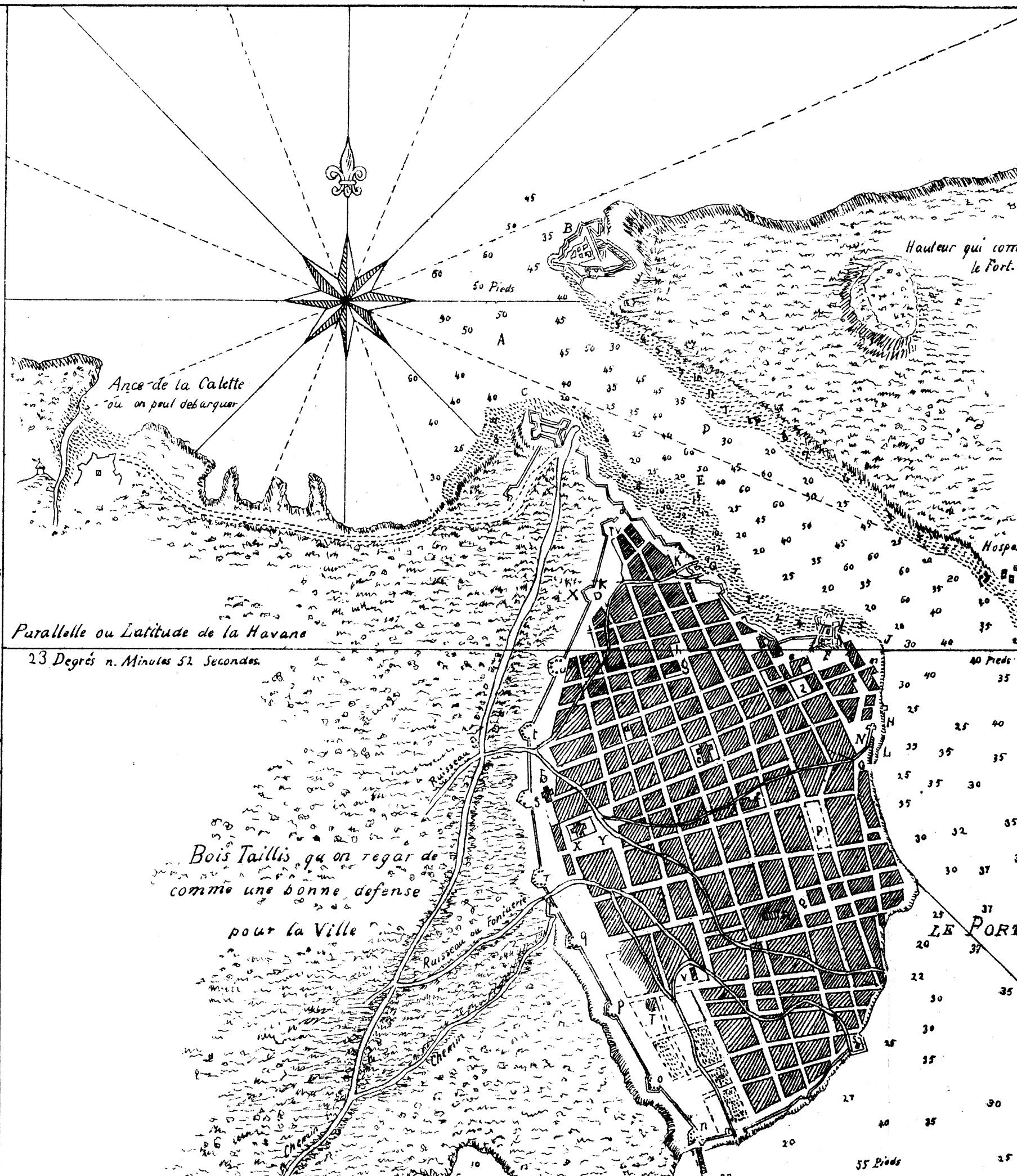
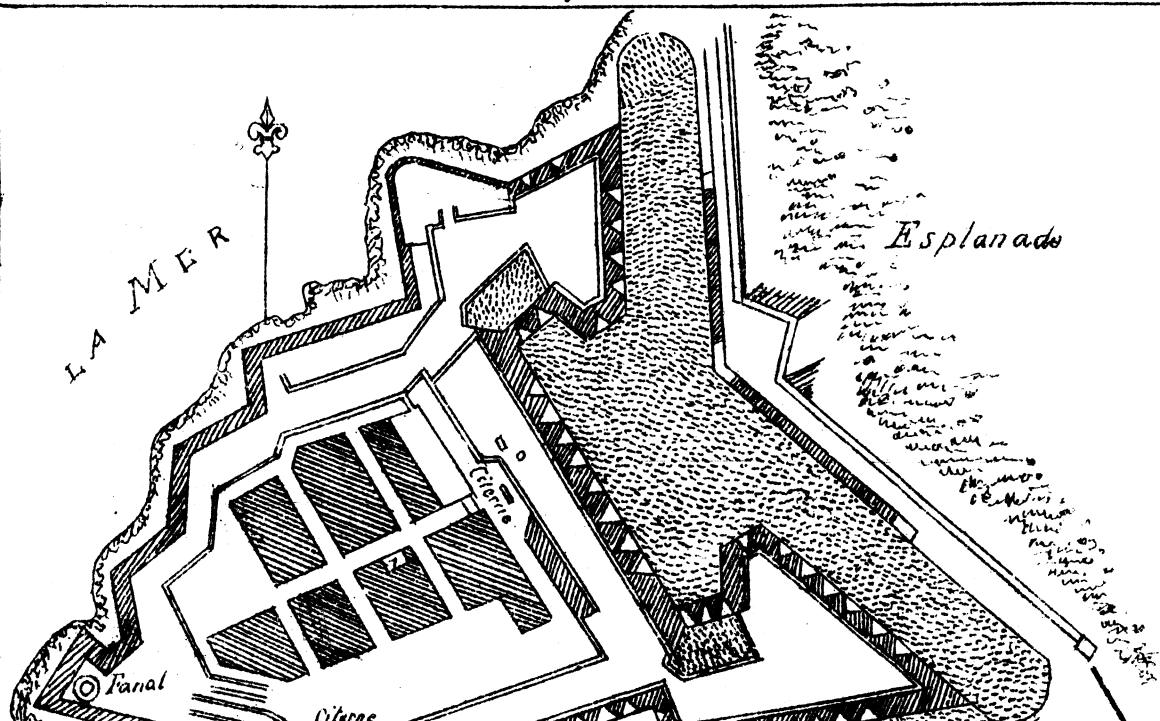


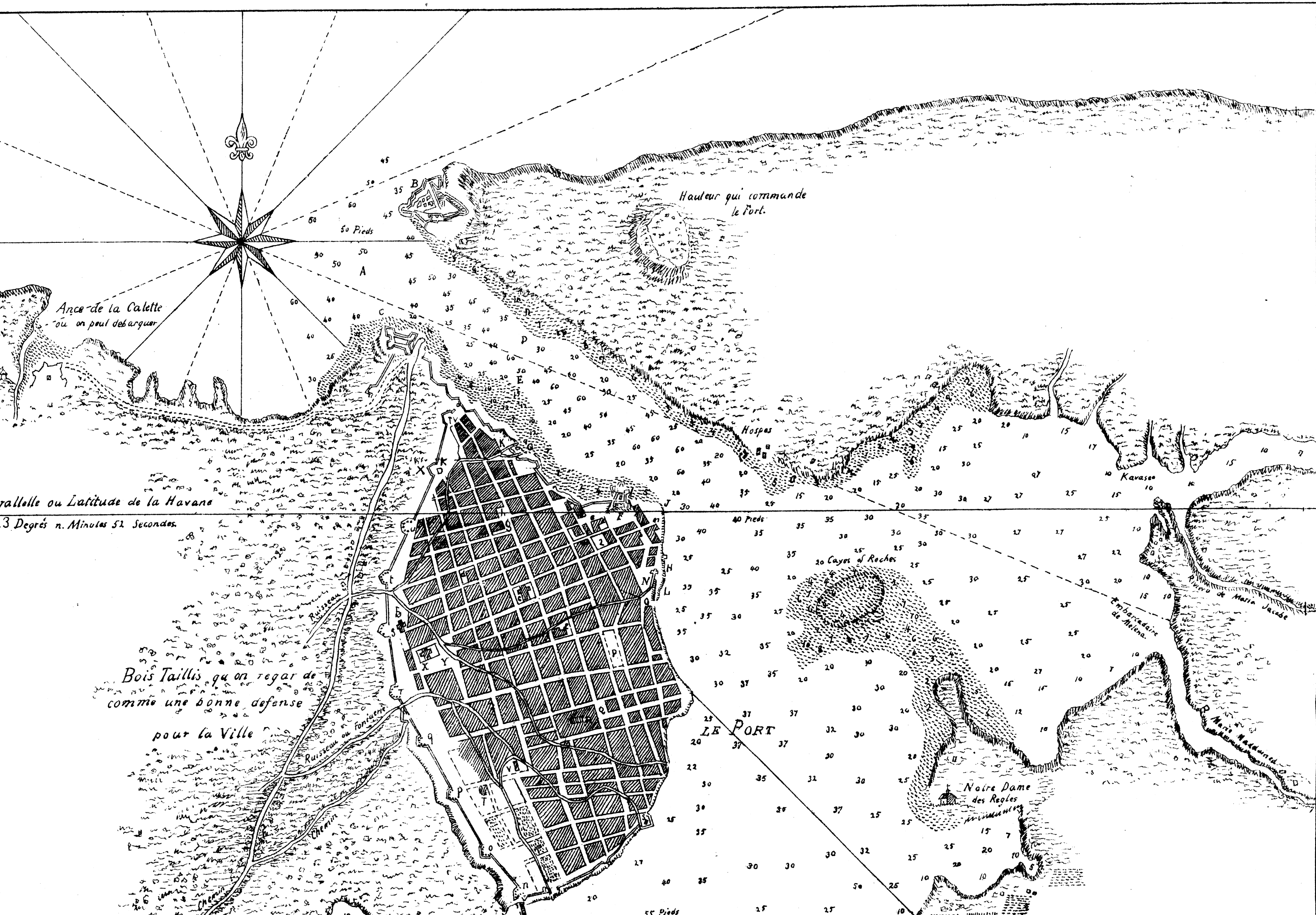
CARTE HYDROGRAPHIQUE DE LA BAYE DE LA HAVANE

Avec le Plan de la Ville et de ses Forts pour joindre a la Carte de l'Isle de Cube.
Dressée au Depot des Cartes et Plans de la Marine pour le Service des Vaisseaux
du Roy Par ordre de M LE DUC DE CHOISEUL Colonel général des Suisses et
Grisons. Ministre de la Guerre et de la Marine. 1762
Par le S^t Bellin Ingenieur de la Marine.

- | | |
|---------------------------------------------------|-------------------------------------------------------------------|
| A. Entree de la Baye. | a Les Augustins. |
| B. Chateau du Maure | b. Notre Dame de Monserat |
| C. Fort de la Pointe. | c. Saint Philippe |
| D. Pointe de Lara | d. Filles de Sainte Therese |
| E. La Cal restante | e. La Cathedrale ou S ^t Christofle. |
| F. Le Vieux Chateau | f. Les Dominicains. |
| G. Fontaines ou l'on fait l'eau. | g. La Charité ou S ^t Jean de Die |
| H. Autre Fontaine ou l'on fait de l'eau. | h. Place de S ^t Jean de Dieu. |
| J. La Pointe du Carénage. | i. Seminaire des Douze Enfants. |
| K. Batterie de S ^t Velmo de 12 Canons. | k Seminaire des 12 Demoiselles |
| L. Batterie du Gouverneur 23 Canons | l. Le S ^t Esprit. |
| M. Maison du Gouverneur. | m. La Cantadurerie. |
| N. Place du Gouverneur | n. Bastion de la Tenaille 2. Canons. |
| O. Les Franciscains. | o. Bastion de S ^t Jacques 6. Canons. |
| P. Place Neuve. | p. Bastion de S ^t Pierre 9. Canons. |
| Q. Place S ^t Claire. | q. Bastion de N ^o D ^e du Rosaire 8. Canons. |
| R. Filles de S ^t Claire. | r. Bastion de S ^t Alphonse 3 Canons. |
| S. Saint Francois de Paule. | s. Bastion de S ^t Christ. 3 Canons. |
| T. Saint Isidore | t. Bastion de N ^o D ^e de Monserat 4. Can. |
| V. Saint Diego. | u. Bastion de S ^t Joseph 2. Canons. |
| X. Saint Christofle du bon Voyage. | x. Bastion de S ^t Jean de Dieu |
| Y. Place de S ^t Christofle. | y. Bastion de S ^t Christofle |
| Z. Les Filles de S ^t Catherine. | |

B Le Fort du Maure ayant 57 Pièces de Canons de fonte.

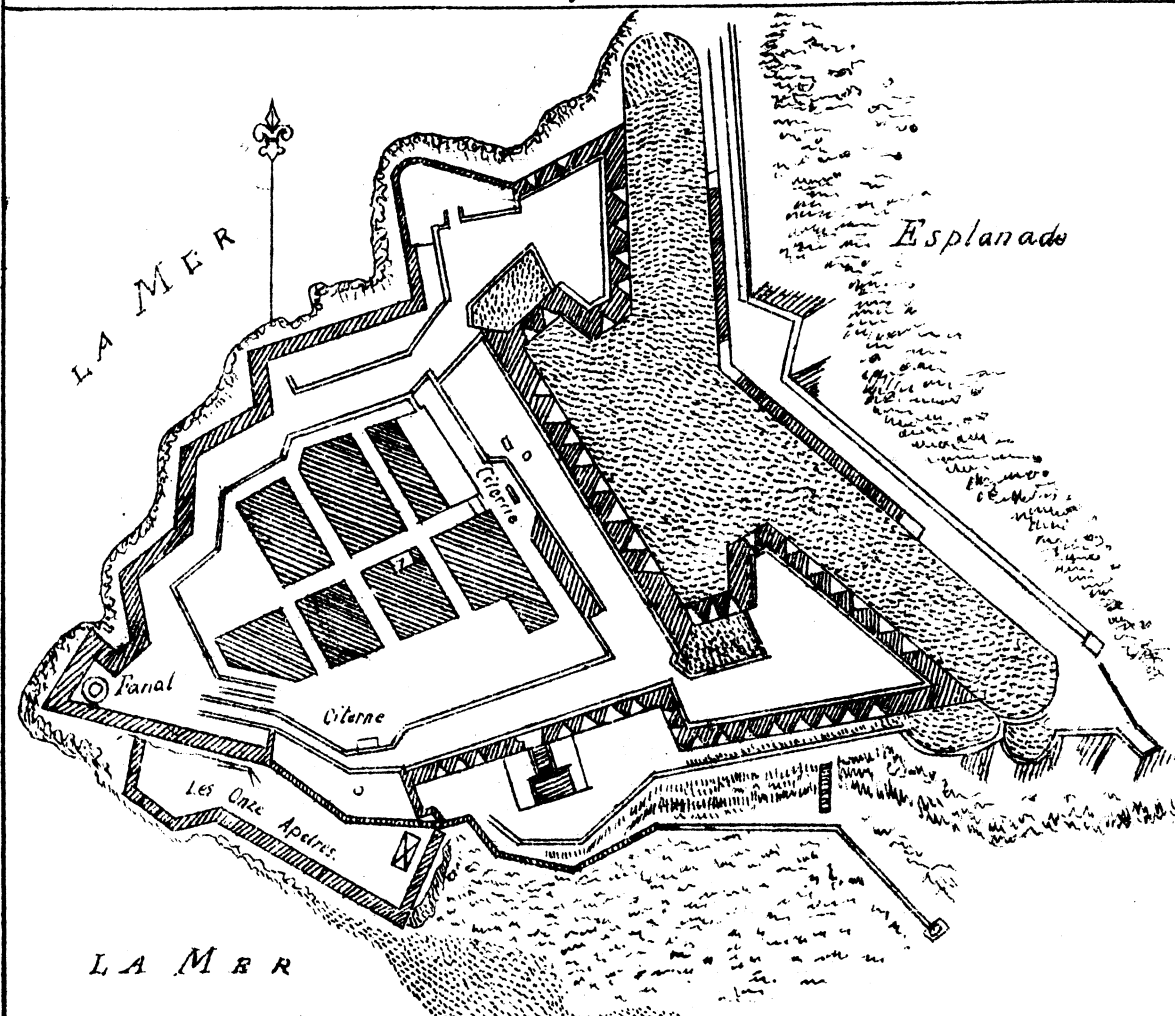




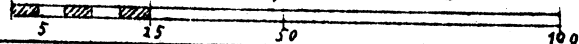
R. Filles de St. Claire.
S. Saint Francois de Paule.
T. Saint Isidore
V. Saint Diego.
X. Saint Christoffe du bon Voyage.
Y. Place de St Christoffe.
Z. Les Filles de St Catherine.

t. Bastion de St Alphonse 3 Canons.
t. Bastion de N. D. de Monserat 4. Can.
u. Bastion de St Joseph 2. Canons.
x. Bastion de St Jean de Dieu
y. Bastion de St Christoffe

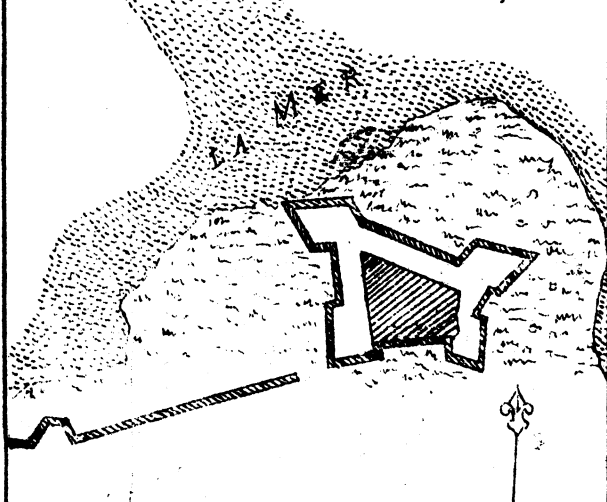
B Le Fort du Maure ayant 57 Pieces de Canons de fonte.



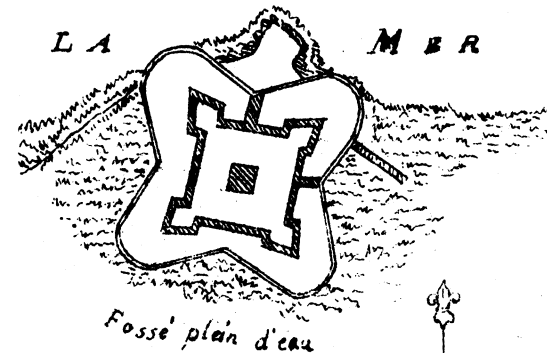
Echelle de Cent Toises pour les trois Forts.



C Le Fort de la Pointe.
ayant 27 Canons de fonte

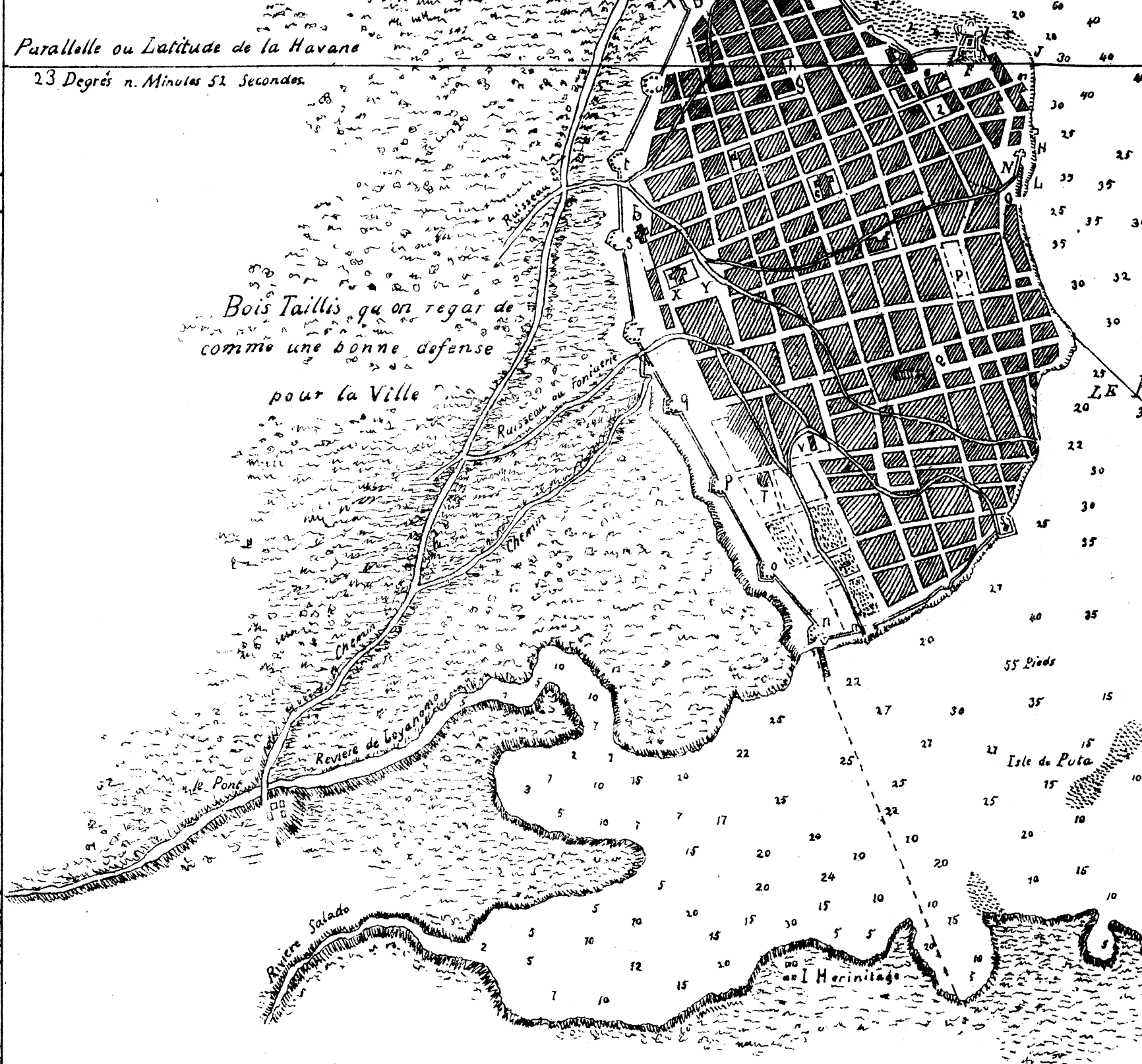


F Le Vieux Chateau
ou La Citadelle ayant 22 Pieces
de Canon de fonte

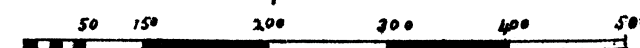


Parallele ou Latitude de la Havane

23 Degrés n. Minutes 51. Secondes.



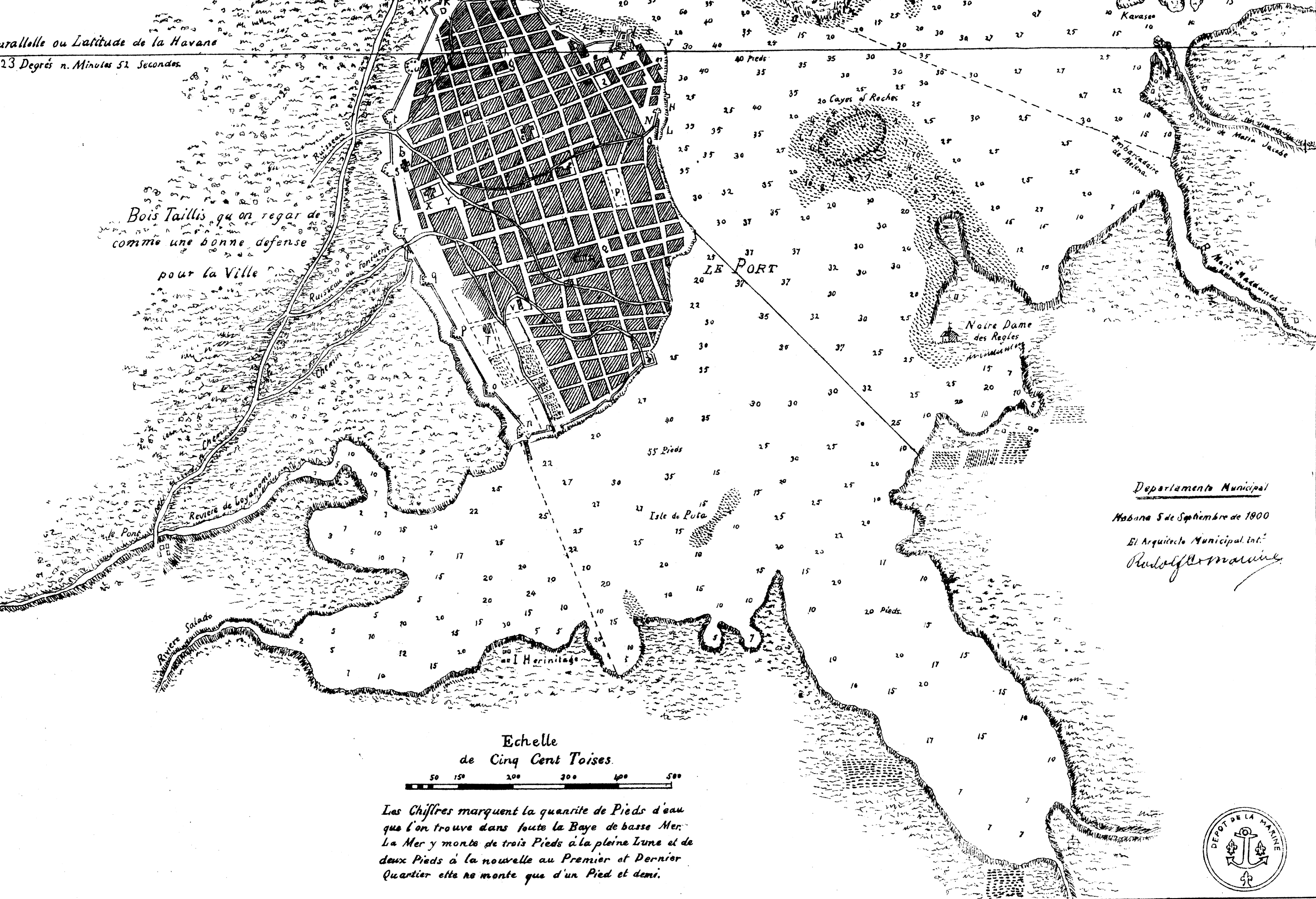
Echelle
de Cinq Cent Toises.



Les Chiffres marquent la quantite de Pieds d'eau
que l'on trouve dans toute la Baye de basse Mer.
La Mer y monte de trois Pieds à la pleine Lune et de
deux Pieds à la nouvelle au Premier et Dernier
Quartier elle ne monte que d'un Pied et demi.

Parallèle ou Latitude de la Havane

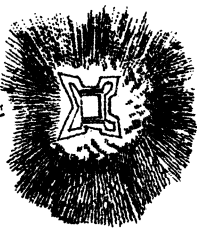
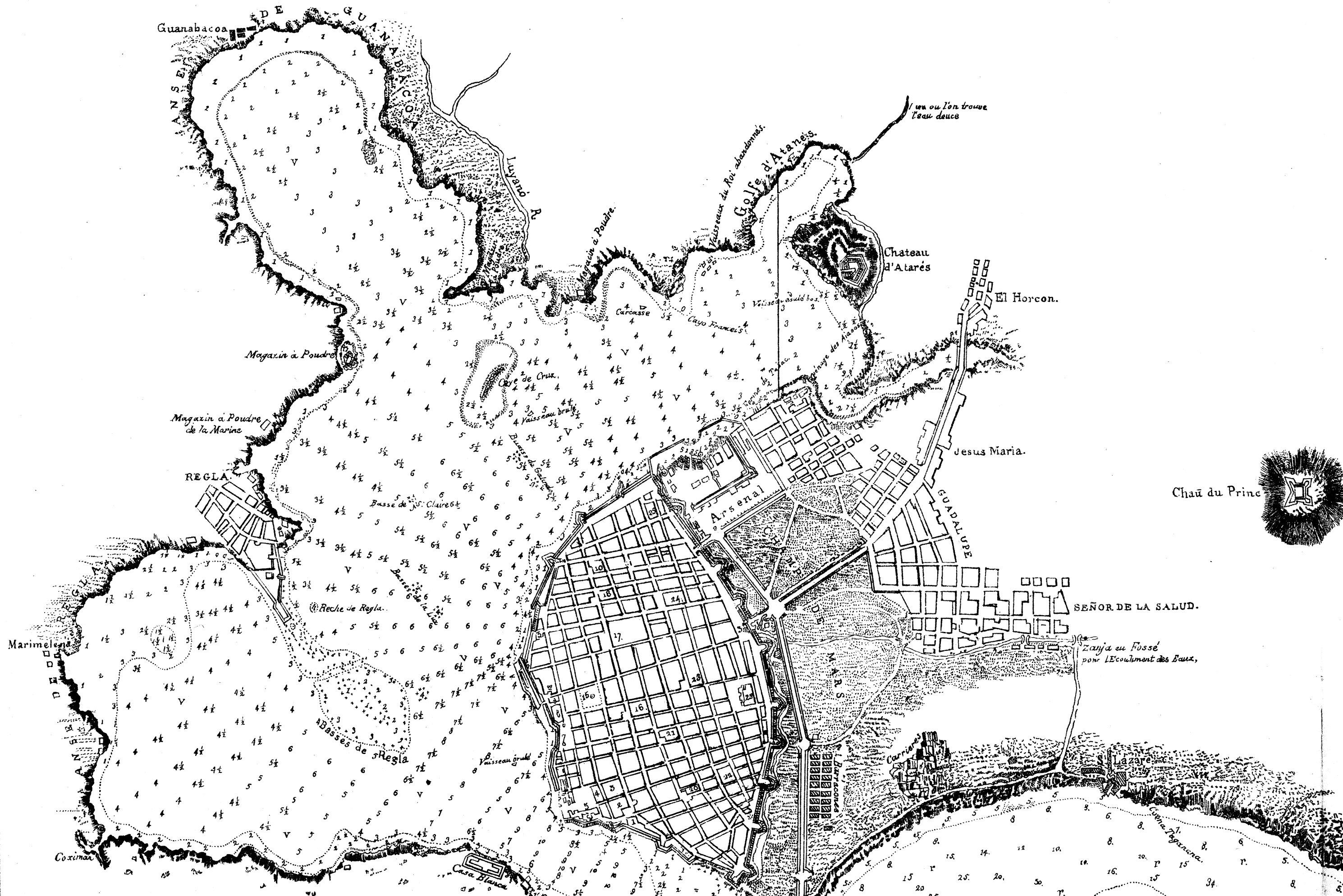
23 Degrés n. Minutes 51 Secondes



Echelle
de Cinq Cent Toises.

Les Chiffres marquent la quantite de Pieds d'eau
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Quartier elle ne monte que d'un Pied et demi.





PLAN DU PORT ET DE LA VILLE DE LA HAVANNE

LEVÉ EN 1798
PAR

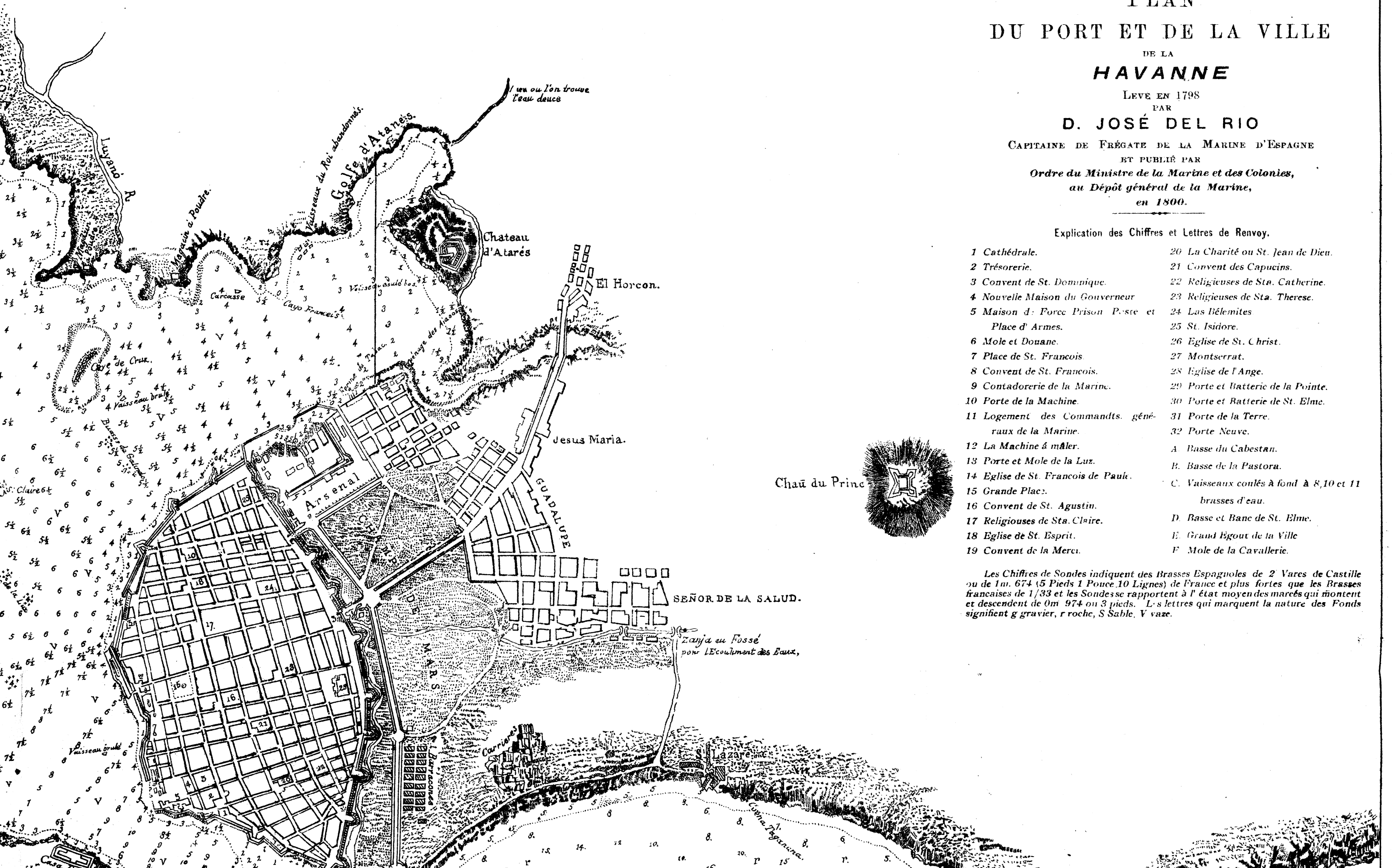
D. JOSÉ DEL RIO

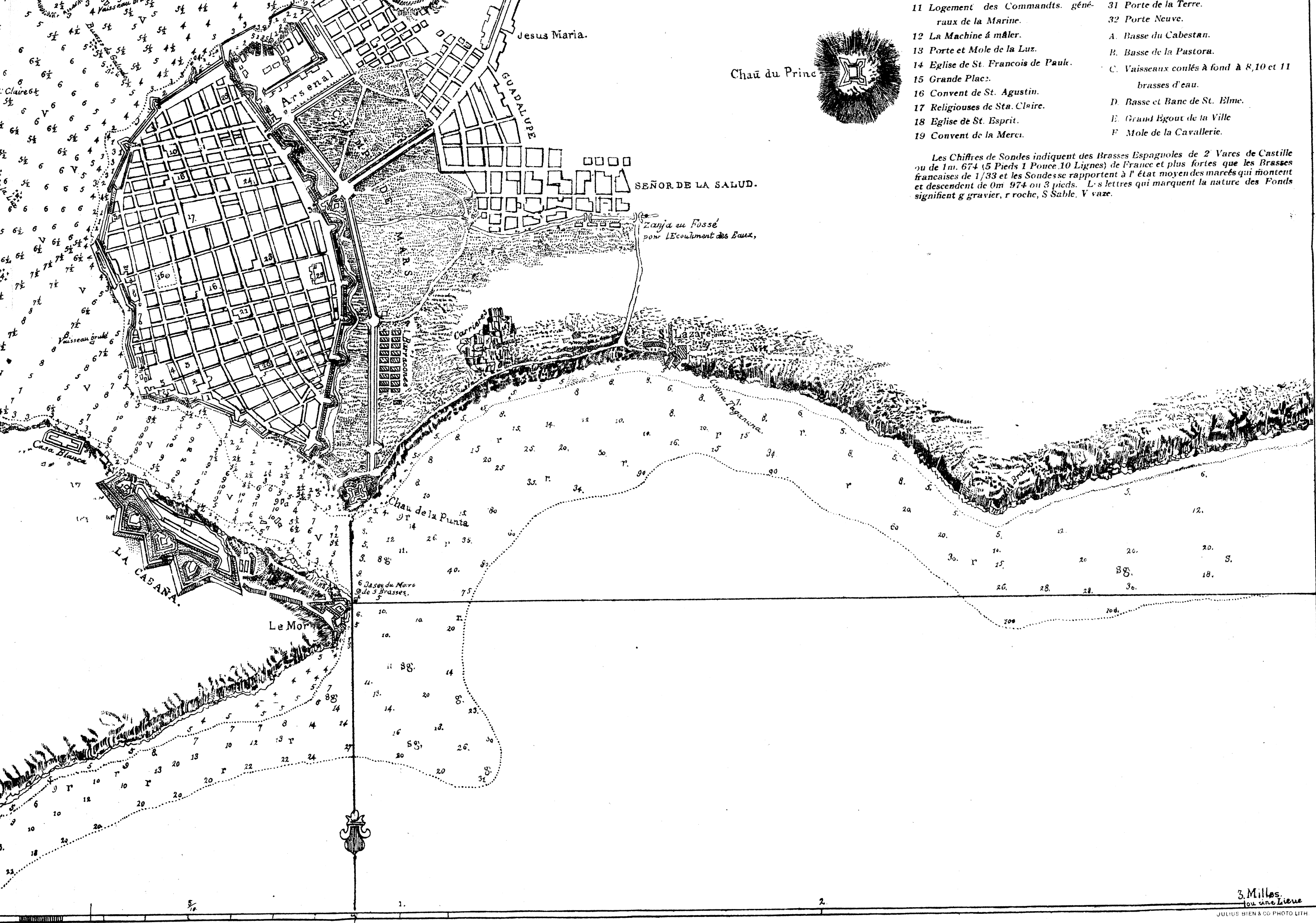
CAPITAINE DE FRÉGATE DE LA MARINE D'ESPAGNE
ET PUBLIÉ PAR
Ordre du Ministre de la Marine et des Colonies,
au Dépôt général de la Marine,
en 1800.

Explication des Chiffres et Lettres de Renvoy.

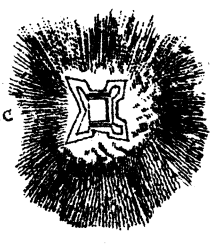
- | | |
|------------------------------------|-----------------------------------------|
| 1 Cathédrale. | 20 La Charité ou St. Jean de Dieu. |
| 2 Trésorerie. | 21 Convent des Capucins. |
| 3 Convent de St. Dominique. | 22 Religieuses de Sta. Catherine. |
| 4 Nouvelle Maison du Gouverneur | 23 Religieuses de Sta. Therese. |
| 5 Maison d: Force Prison Poste et | 24 Las Bêlémities |
| Place d' Armes. | 25 St. Isidore. |
| 6 Mole et Douane. | 26 Eglise de St. Christ. |
| 7 Place de St. Francois. | 27 Montserrat. |
| 8 Convent de St. Francois. | 28 Eglise de l'Ange. |
| 9 Contadorerie de la Marine. | 29 Porte et Batterie de la Pointe. |
| 10 Porte de la Machine. | 30 Porte et Batterie de St. Elme. |
| 11 Logement des Commandts. géné- | 31 Porte de la Terre. |
| raux de la Marine. | 32 Porte Neuve. |
| 12 La Machine à mûler. | A Basse du Cabestan. |
| 13 Porte et Mole de la Luz. | B. Basse de la Pastora. |
| 14 Eglise de St. Francois de Paul. | C. Vaisseaux coulés à fond à 8,10 et 11 |
| 15 Grande Place. | brasses d'eau. |
| 16 Convent de St. Agustin. | D. Basse et Banc de St. Elme. |
| 17 Religieuses de Sta. Claire. | E. Grand Égout de la Ville |
| 18 Eglise de St. Esprit. | F. Mole de la Cavallerie. |
| 19 Convent de la Merci. | |

Les Chiffres de Sondes indiquent des Brasses Espagnoles de 2 Vares de Castille ou de 1m. 674 (5 Pieds 1 Pouce 10 Lignes) de France et plus fortes que les Brasses francaises de 1/33 et les Sondesse rapportent à l' état moyen des marées qui montent et descendent de 0m 974 ou 3 pieds. Les lettres qui marquent la nature des Fonds signifient g gravier, r roche, S Sable, V vase.





Chau du Prince



- | | |
|------------------------------------------------------|-----------------------------------------------------------|
| 11 Logement des Commandts. gé- raux de la Marine. | 31 Porte de la Terre. |
| 12 La Machine à mûler. | 32 Porte Neuve. |
| 13 Porte et Mole de la Luz. | A. Basse du Cabestan. |
| 14 Eglise de St. Francois de Paul. | B. Basse de la Pastora. |
| 15 Grande Place. | C. Vaisseaux coulés à fond à 8,10 et 11 brasses d'eau. |
| 16 Convent de St. Agustin. | D. Basse et Banc de St. Elme. |
| 17 Religieuses de Sta. Claire. | E. Grand Egout de la Ville |
| 18 Eglise de St. Esprit. | F. Mole de la Cavallerie. |
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15

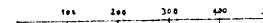
Números de las casas.

Los números colocados en las manzanas indican el mayor que tienen las casas de la acera en cuyo centro se hallan. Así, pues, es fácil saber v. g. que la casa número 114 de la calle del Obispo se halla entre las calles de la Habana y Aguilar, porque en una de las aceras de esta cuadrada están comprendidas las casas que llevan desde el número 111 (que es el que sigue al 110, mayor entre Compostela y Habana) hasta el 115 indicado el último de dicha cuadrada. La casa número 109 calle del Sol, ha de hallarse entre las de Cuba y Aguilar.

PLANO PINTORESCO DE LA HABANA

CON LOS NUMEROS DE LAS CASAS

Dedicado por el autor
a la memoria de su tío el Sr. Coronel
D. Antonio María de la Torre y Cárdenas,
1859.



Desde 19 de Enero de 1858 está mandado que rija la siguiente

DIVISION DE LA CIUDAD EN BARRIOS INTRAMUROS

1er. Distrito

- | 1er. Distrito. | 2º Distrito. |
|----------------------|------------------------|
| 1q Templete..... | 1q San Francisco |
| 2q San Felipe..... | 2q Santa Clara |
| 3q Santo Cristo..... | 3q Santa Teresa..... |
| 4q San Juan de Dios. | 4q Paula |
| 5q Santo Angel | 5q San Isidro |

EXTRAMUROS

- | | |
|-------------------|----------------------|
| 1ª Tacón..... | 5ª Monserrate..... |
| 2ª Colón..... | 6ª Dragones..... |
| 3ª La Punta..... | 7ª San Leopoldo..... |
| 4ª Guadalupe..... | 8ª San Lázaro..... |

EXTRAMUROS

- 10 Distrito.**
- 10 Arsenal.....
- 20 Jesús María.....
- 30 La Ceiba.....
- 40 Vives.....
- 50 San Nicolás.....
- 60 Marte.....
- 70 Chavex.....
- 80 Peñalver.....
- 90 Pueblo Nuevo.....

- 6.º Distrito (Regla).
1.º Santuario.
2.º Cementerio.

- 39 Distrito.
- | | |
|----|----------------------|
| 19 | Atarés..... |
| 29 | Pinar..... |
| 39 | Villanueva..... |
| 49 | Jesús del Monte..... |
| 59 | Cerro..... |
| 69 | Príncipe..... |
| 79 | Arroyo Apolo..... |

Casa Blanca.
Se incluye en el
barrio
del Templo.

